SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JANUARY 1908.

GENERAL PHYSICS.

1. *Simplification of the Gallenkamp Registering Rain Gauge.* **A. Sprung.** (Zeitschr. Instrumentenk. 27. pp. 340–343, Nov., 1907.)—The Gallenkamp apparatus (described in Meteorolog. Zeitschr. 22. p. 1, 1905) resembles in some features the registering gauge of Fuess and the author of 1889. The hour marks are not points but lines, drawn from right to left, 30 or 60 mm. in length, and the drum revolves once every 15 min. As the Horner cup is very small, some rain-drops might fall on the cup while it is tilting, and the author therefore makes the drops register themselves electrically. The funnel ends in an **S**-shaped tube, and the drop runs down between two pieces of copper or platinum-foil, thereby closing an electric contact; the shape of the contact-pieces excludes the possibility of a lasting short-circuit. H. B.

2. *Accuracy o; Modern Micrometers.* **M. D. Ewell.** (Amer. Phil. Soc., Proc. 46. pp. 187–190, Jan.–March, 1907.)—Eight modern scales on glass by different makers have been compared, and two older ones (of 25 years ago). No advance in precision is shown, the results not even equalling those of the early period. Exceptionally good results are, however, shown by a glass scale by Leitz and a photograph by Möller. On the other hand, the maximum (+ and —) divergence in a glass scale by Watson is $4{\cdot}6\,\mu$ in 1/10 mm. ($100\,\mu$), and in one by Bausch and Lomb $2{\cdot}8\,\mu$. L. H. W.

3. *Effect of Current upon Friction.* **P. R. Heyl.** (Phys. Rev. 25. pp. 429–432, Nov., 1907.)—The current flows across the surface of separation of two substances. Two rods connected by a metal framework dip into vessels of mercury, the current passing in at one, through the framework, and out at the other. The arrangement is suspended by a wire, and is loaded to give a period of about 25 sec. The decrement is observed with and without the current, in order to determine whether the friction between the mercury and the rod is affected by the current. Two sets of experiments were made, one with iron rods and the other with carbon rods, as these two substances are unattacked by mercury. With a current density of 80 amps./cm.^{2} there is no

change in friction as great as 1 per cent. in the case of iron, whereas in the case of carbon there is a decrease of 14 per cent.; but it is shown that this is entirely due to the heating produced by the current. S. G. S.

4. *Determination of the Hardness of Elastic Solids.* **T. E. Frizendorf [Friesendorff].** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 38. No. 3. Physical Part, pp. 464–466, 1906.)—The depth of indentation below the plane surface of the body, the hardness of which is required, by a sphere of radius R under the pressure P is given by the equation : $W_0 = 3PC/16a = (9P^2C^2/256R)^{\frac{1}{3}}$, in which a represents the radius of the contour of the indentation. The coefficient C, the reciprocal of which may be regarded as the index of hardness of the body, is connected with Young's modulus, E, and with Poisson's coefficient, η, by the expression : $C = 4(1-\eta^2)/E$, and can hence be calculated; for substances like glass it can be found by measuring the radii of the pressing sphere and of the contour of the indentation. T. H. P.

5. *Method of making Elastic and Strength Tests.* **M. Grübler.** (Phys. Zeitschr. 8. p. 879, Nov. 15, 1907. Paper read before the 79 Naturforscher-versamml., Dresden.)—A cylindrical ring of the substance under test is threaded upon an iron cylinder, and an iron frame is then cemented to its outside surface. These two are then submitted to a pull in the direction of the common axis, which gives a shear upon concentric cylindrical surfaces in the specimen. If T is the shear stress at distance r from the common axis, and h the height (assumed invariable) of the ring, then M the moment of the load, at r, is $= 2\pi h r^2 T$. The relative amount of shear between two surfaces of radii r and r_1 respectively is $v = M(1/r_1 - 1/r)/2\pi h$. The first equation is used to evaluate the shear strength, and, together with the second, to determine the modulus of elasticity in shear (C). If Young's modulus be known, Poisson's ratio can, of course, be calculated. Experiments on these lines upon a ring of cement mortar (1 part cement to 3 parts sand) kept 100 days in water, gave $C = 15{,}000$ and $T \geqq 33{\cdot}0$ atmos. (The surface unit is not stated.) F. R.

6. *Lateral Vibration of Bars, treated simply.* **E. H. Barton.** (Phil. Mag. 14. pp. 578–591, Nov., 1907.)—Neglecting from the start the rotational energy of the elements of the bar, and assuming that in all cases deflection is so small that the curvature may be considered proportional to d^2y/dx^2, the solution is reached more simply than in Rayleigh's analysis ("Theory of Sound," 1. pp. 255–296). In the ordinary analysis for static loading of a beam, the first derivative of the bending moment at any point is equal to the shearing force at the point, and the second is equal to the impressed forces per unit length containing the point. Thus the acceleration of an element of the bar when vibrating is proportional to the second derivative of the bending moment, and hence to the fourth derivative of the displacement with respect to distance along the bar. The resulting equation, $d^2y/dt^2 + K^2b^2 \,.\, d^4y/dx^4 = 0$, is identical with that of Rayleigh. Here, $b = \sqrt{E/\rho}$, K is the radius of gyration of the section about the neutral surface, and ρ is the density. The solution of this equation is for the rest practically the same as given by Rayleigh. In several cases experimental results are compared, and even in the case of a steel bar 29 in. × 1¼ in. wide × ¼ in. deep, with free ends, the agreement of the observed and calculated positions of the nodes is very close, showing the slightness of the error introduced by neglecting rotation, even in the case of a relatively thick bar. F. R.

7. *Bending of Material which does not follow Hooke's Law.* **E. Meyer.** (Phys. Zeitschr. 8. pp. 827–831, Nov. 1, 1907.)—On the assumptions that plane cross-sections remain planes upon bending the bar (which is of uniform rectangular section of height h and breadth b), and that the relation between extension or compression (ϵ) and direct stress (σ) in each layer parallel to the neutral axis is the same as that in a test under direct stress, it is first shown, as already pointed out by Bach, that the bending moment at any section is $M = bh^2N/a^2$, where $N = \int_{-\epsilon_2}^{+\epsilon_1} \sigma\epsilon . d\epsilon$, ϵ_1 and ϵ_2 are the max. compressive and tensile strains, and $a = \epsilon_1 + \epsilon_2$. The angle of bending (between centre and end), under a single central load P, the beam being supported at each end, is $\beta = 2bhF_\beta/P$, and the central deflection $= 4b^2h^3F_f/P^2$. F_β is the area under the curve a as a function of N/a^2, and F_f the area of aN/a^2 as a function of N/a^2, in each case bounded by the N/a^2 axis and the ordinate corresponding to $N/a^2 = Pl/4bh^2$. For a section other than rectangular the method of computation is substantially the same. In the case of cast-iron specimens the difference between observed and calculated deflections ranged from 0 to 4·4 per cent. with rectangular section, 8·4 to 15 per cent. with square section, and 0 to 1·2 with concentric circular section. With annealed mild steel the agreement was very close throughout; both deflection and bending angle were observed. The agreement in the later stages of the curves was best when the lowest of the values of the elastic limit given in direct tests was adopted for the calculation. The principal discrepancy between the curves occurred in the neighbourhood of the elastic limit, which appears high in bending tests, as it is first reached in only the extreme layers. Reference is made to the results mentioned in Abstract No. 179 (1907). F. R.

8. *Activity of the Royal Depôt for Testing Materials, in* 1906. (Königl. Materialprüfungsamt, Mitt. 25. 4. pp. 157–281, 1907.)—An account is given of work in progress or completed during 1906, in the five sections, viz., testing of metals, testing of building materials, metallography, general chemistry, oil testing. An improved arrangement for allowing only a desired load to be applied to a specimen in the testing machine is said to have given better satisfaction than the earlier entirely hydraulic type. The gauge pointer makes contact with a stop, closing an electric circuit which actuates the hydraulic valve. Failure of a rail butt joint for a street railway commenced to occur with a load of 45,000 kg., when placed on supports 1 m. apart. The crushing load for bearing balls of $\frac{5}{16}$ in. diam. by Rudeloff's method is from 640 to 960 kg. Comparative tests were made in various ways and at temperatures from atmospheric to 400° C. of pipe flanges of mild steel and of cast steel. In almost every test the former proved superior. In tearing the pipe from the flange the two materials behaved equally well, however, up to 200°. In torsion tests of a motor-car cardan-shaft, using a sphere of 7 cm. diam., failure occurred with a twisting moment of 18,870 kg.-cm., and with a 5·5 cm. diam. ball at 8,980 kg.-cm. Annealed samples cut from a copper steam pipe had a tensile strength at atmospheric temperature of 2,100–2,160 kg./cm.^{2}, and at 400° C. of 730 to 1,000 kg./cm.^{2}. The effect of temperature on elongation varies with different coppers, and is in some cases an increase up to 300°, in others a decrease throughout the range. The number of repeated bendings through 180° each way withstood was greater with increasing temperature up to 300° C., and then fell away. A report on strength of metals at temperatures higher than atmospheric is about to appear. Steel plate with a tensile

strength of 8,920 kg./cm.² and 15·2 per cent. elongation at atmospheric temperature, has, at 250°, 9,850 kg./cm.² and the same elongation. The coefficient of expansion for hard rubber specimens was found to be from 0·00004188 to 0·00008878 per 1° C. The corrosion of metals in water and various solutions is under investigation. The following results were obtained with iron pipes galvanised in two different ways, A and B. The relative amounts of corrosion of zinc are stated in terms of two different units, *k* and *k′*.

Duration of Immersion.	25 Minutes.		46 Days.	
	HCl (1 : 100).	H_2SO_4 (1 : 100).	Distilled Water.	Tap Water.
Galvanising A	100 *k*	300 *k*	100 *k′*	53 *k′*
Galvanising B	380 *k*	611·8 *k*	230 *k′*	34·5 *k′*

F. R.

9. *Proportioning of Railway Bridge Members.* **H. S. Prichard.** (Eng. News, 58. pp. 301–304, Sept. 19, 1907. From Engineers' Soc. of Western Pennsylvania, Proc. July, 1907.)—The following views refer to usual railway bridge steel. Safe working tensile stress in main members, 16,000 lbs. per sq. in.; safe loads on compression members, 15,000 lbs. per sq. in., reduced according to length of member. Members liable to stresses ranging from $+a$ to $-b$ should be proportioned so as to be capable of withstanding either of these extremes increased by F per cent. of the lesser of the two; with riveted end-connections F is 50, with pin ends F is 100. The following formulæ may be used in design, the basis being 16,000 lbs. per sq. in. ordinary max. tensile stress, 32,000 lbs. per sq. in. contingency limit, and possible future live loads 50 per cent. greater than specified, increasing the ordinary stress to 20,000 lbs. per sq. in. D is the dead load stress; L, the static stress from specified live load; I, the addition for dynamic effect of the specified live load; P, the amount to be added to live load stresses and impact to provide for the possible future increase in load. When live and dead load stresses are of same sign—

$P = \frac{1}{5}(L + I - D)$; when of opposite kinds,
$P = \frac{1}{5}(L + I + D)$, or $\frac{1}{3}D$, whichever is greater.

F. R.

10. *Strength of Hooped Concrete Columns.* **A. N. Talbot.** (Eng. News, 58. pp. 342–344, Sept. 26, 1907. Abstract of Report to the Amer. Soc. for Testing Materials, June 22, 1907.)—The columns tested were 10 ft. long, and mostly 12 in. diam., a few, however, being 9 in. diam. The concrete was 1 : 2 : 4 (stone), and 60 days old when tested. It had set in air. The reinforcement (if any) was in the form of (*a*) hoops made of welded strip, or (*b*) a wire spiral. Poisson's ratio was observed to be 0·1 for low loads and about 0·25 to 0·3 near crushing load. The hoops seem to have little effect until a load equal to the crushing load of the concrete is reached; at this load skin cracks and peeling commence. The total shortening of hooped columns before failure was about 8 to 10 times that of similar unreinforced columns. Light hooping offers security

against failure by sudden increase of stress, and allows of using higher working stress. In combination with rich concrete, and longitudinal enforcement, using low stresses in these light hoops, satisfactory columns may be made. Heavy hooping gives added strength, but this is only available upon undue shortening of the column. Hence longitudinal reinforcement may not be favourably combined with heavy hooping. It was observed, in the mixtures used, that the compressive strength of the plain concrete was practically proportional to the amount of cement in the mixture. F. R.

11. *Effect of Time in Loading Concrete Beams.* **W. K. Hatt.** (Eng. News, 58. pp. 438–439, Oct. 24, 1907. Paper read before the Amer. Soc. for Testing Materials, June 22, 1907.)—The tests were made on beams 8 in. × 10 in. × 9 ft. and 8 in. × 8 in. × 6 ft. with about 1 per cent. of steel rod reinforcement, the beams being about 60 days old. A beam loaded in the ordinary way in the testing machine to a stress of 16,000 lbs. per sq. in. in the steel deflected 0·14 in. Upon unloading and reloading 450 times the deflection reached 0·24 in. A similar beam under constant load for 2 months had deflected 0·29 in. Repeated loading did not affect the ultimate load. It is suggested that this continued deflection, only a small part of which is permanent, is in part a slipping of the steel in the concrete, and more especially a set in the concrete itself. The stress-strain curves become more nearly straight lines with repeated loading. The results of some impact tests of beams under falling weights are given, but these are not regarded as conclusive, as the weights were probably not heavy enough; the beams broke on the compression side by cracking between the centre and point of support. F. R.

12. *The le Chatelier Cement Test.* **W. L. Gadd.** (Engineer, 104. (pp. 251–252, Sept. 13, 1907.)—It is found that cement well burned from clinker in the rotary kiln almost invariably gives a greater expansion under the le Chatelier test (as incorporated in the British Standard Specification) if it be first aërated—an increase of 8 to 12 mm. after 7 days' aëration being observed. A number of experimental results are given which tend to support the following explanation of this effect. The cement as ground may be divided into three portions—the finest flour, which is hydrated more or less completely upon gauging; the coarsest particles of clinker grit, which are hydrated only superficially, and act throughout as inert material; the fine particles of clinker, say those which pass the 180-mesh sieve, but which are not so fine as the flour, and which continue to hydrate with consequent expansion, when the block is boiled. The following modifications are proposed to the le Chatelier test in the Specification: (1) Cement to be gauged fresh, or after laying out for 12 to 24 hours only. (2) The mould to be immersed in cold water for at least 48 hours, and, if necessary, 7 days, before boiling. (3) The total expansion from the moment of setting, in both the cold and boiling water, to be measured. (4) Aëration of the cement for 7 days to be optional. F. R.

13. *Curvature Method for Surface Tension.* **C. V. Raman.** (Phil. Mag. 14. pp. 591–596, Nov., 1907.)—Following the suggestion of Kelvin, the author uses the curvature of a drop hanging from a tube to determine the surface tension of the liquid, the measurements being taken from a photograph. Two values found for water are 77 and 76·3 dynes per cm. at 30° C., whereas in 1893 T. P. Hall (Phil. Mag.) found 71·8 at the same temperature. E. H. B.

14. *Estimation of Cloudiness.* **E. Leyst.** (Soc. Imp. Nat. Moscou, Bull. 3 and 4. pp. 217–269, 1906.)—An inquiry into the question with special regard to Russian observations, taken three times a day. The Meteorological Congress of Vienna 1873, designated a perfectly serene sky by 0, and a quite covered sky by 10; the density of the clouds was not to be taken into consideration, and no instructions were given as to the way in which the observer is to divide the area of the sky into ten parts. Owing to our impression of the shape of the celestial vault and to perspective effects, the extent of the lower cloud zones is generally overestimated. In 1895 the author fixed at Moscow concentric wire rings at different heights such that the observer standing in the centre of the rings would see the sky divided into zones of 10°. When the degree of cloudiness is estimated from observations confined to the zone 0 to 30°, the values are for Moscow about twice as large as when the zone 60 to 90° is observed. The diurnal and yearly variations in cloudiness are not the same near the zenith as near the horizon; the yearly amplitude becomes greater when the horizontal zone is excluded, and there are more serene days in this latter case. When observations are taken for the whole sky, the resulting cloudiness-figure would correspond to 39°, and not to 45°. Considering that the personal error (Laurenty) seems to affect observations taken near the horizon most, the author suggests that the cloudiness-figure should be referred to the zone 60 to 90°, which could be marked off with the aid of wires. H. B.

15. *Meteorological Observations at Moscow in* 1906. **E. Leyst.** (Soc. Imp. Nat. Moscou, Bull. 3 and 4. pp. 402–442, 1906.)—The observations [see Abstract No. 790 (1907)] have been continued as before by A. Speranskij, Gurjanow, and M. Lebedew. The air pressure in March was very low, 736·8 mm. (average 748·9). The whole year, except Aug. and Sept., was too warm; May was by 0·5° warmer than June; the last four years have all been too warm, but the end of the summer rather cool. The greatest differences between radiation thermometers and air thermometers do not as a rule coincide with the maximum values of the former. The maximum of absolute humidity, 22·7 mm., recorded on Aug. 5, at 3 p.m., is the highest observed at Moscow; the relative humidity was 91 per cent., the temperature 26°, and a thunderstorm followed immediately afterwards. Rain was deficient in the first half of the year, excessive in Nov. when the barometer was normal. The predominating wind of the year was from south-east; there were hardly any winds from north-east during the first three months. H. B.

16. *Thunderstorm Observations in the Alps.* **A. v. Obermayer.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2a. pp. 723–758, April, 1907.)—Bezold pointed out, in 1869, that the thunderstorms in Bavaria had two frequency maxima, the first occurring in the first half of June and the second absolute maximum in the latter half of July. Examining the records from some summit stations, and their foot stations in the Alps—Sonnberg, 3,095 m., foot station, Bucheben; Schmittenhöhe, 1,935 m.; Schafberg, 1,776 m.; Hochobir, Carinthia, 2,044 m., foot stations, Klagenfurt, and Kremsmünster; Hohenpeissenberg, 989 m., foot station, Munich—the author finds that the maxima fall in the first ten days of June, and the second decade of July (absolute maximum), and that there is frequently a third, less distinct maximum in September. The Sonnblick station hut is rarely struck by lightning, probably because it is fairly well protected on the Melsens plan, the earth connection down to Lake Pilatus having a length of 2,250 m.; yet the house was struck 23 times

in the years 1888 to 1906. Such cases are much more frequent on the Hochobir, and on other summits. Arranging Prohaska's thunderstorm statistics for Styria, Carinthia, and Carniola for the years 1885 to 1892 and 1896 to 1902, according to his monthly periods of ten days, the author finds the following frequency figures, covering fifteen years: May, second decade, 4,988, third, 7,938; June, first, 14,409, second, 8,915, third, 11,314; July, first, 13,160, second, 15,228, third, 14,205; Aug., first, 13,653, second, 9,947. The diurnal minimum lies between 4 and 8 a.m., the maximum between 3 and 5 p.m., or later; on the Sonnblick, thunderstorms are equally frequent all the afternoon and evening between 4 and 10 p.m. H. B.

17. *Theory of Synoptical Air-pressure Variations.* II. **F. M. Exner.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2a. pp. 819–854, April, 1907.)—In the first part of his deduction [see Abstract No. 378 (1907)] the author had come to the conclusion that a pressure wave travelled from W. to E. across a continent, and that the depression became most accentuated in the central portions. Thus in winter the pressure should be lower in the central districts than on the eastern and western coasts. As this is not in accordance with facts, he abandons the adiabatic movement of the air; he also forsakes some further limiting assumptions, and emphasises that his present deductions and conclusions should merely be regarded as hypothetical. The pressure variations move eastward with a fairly constant velocity, which depends upon the seasons, however. They are modified by the warming or cooling influences of oceans and continents. With the changes in the air pressure varies also the movement of the mass of air passing in unit time over a spot. The fluctuations of pressure under the influence of the heat supply take place about a mean value which is indicated by the average isobars. In addition to this "thermal wave," the air pressure is influenced by the advance of the pressure wave from the west; the combination of the two waves gives rise to complicated waves of long periods. These relations can be expressed by a differential equation which, the author admits, seems to ascribe too much to the initial distribution. We know too little about the dQ/dt which is dependent also upon time; local heat and cold centres can give rise to renewed pressure maxima and minima. The details of the distribution of land and water modify the initial pressure-distribution considerably. The author is aware that there is hardly any proof for the existence of his thermal wave, except that the depressions which approach the west coast of America from the Pacific in the winter sometimes seem to be arrested for several days at the coast, whilst in other cases they travel on without being impeded. H. B.

18. *The Fundamental Interval in Meteorological Studies, especially in Charts of Isohyetal Lines.* (Monthly Weather Rev. 35. pp. 306–310, July, 1907.)—The author discusses the difficulties of comparing averages for different districts, due to the differences in the periods of observations, in the methods and in the views of the observers, basing his remarks upon G. Hellmann's three volumes on the "Precipitation of the Watersheds of the North German Rivers." Hellmann's records begin with the year 1701, when there was one rainfall station in Germany, while there were 3,672 in 1890. His fundamental period is the fifty years' interval, 1851 to 1900. Particular reference is made to the style of rain gauge, the exposure of the gauge, annual variability and periodicity, local rains, and periodic variations. For computing the annual rainfalls of those fifty years, Hellmann had complete records from only 109 stations, and he reduced the shorter and fragmentary series of observations

for his purpose. In order to determine the influence of the distance between pairs of stations, for instance, Hellmann compared the records from Berlin with those of 24 other stations at distances varying from 94 to 655 km. The paper is practically a review of Hellmann's book. [Compare also Abstract No. 985 (1905).] H. B.

19. *Evaporation of Water over Lakes and Reservoirs.* I. *Proposed Study of the Problems at Salton Sea, California.* **F. H. Bigelow.** (Monthly Weather Rev. 35. pp. 311–316, July, 1907.)—The Salton Sea was formed by an overflow of the Colorado River, which in past times used to discharge its waters alternately into the Gulf of California and into the Salton Sink (depression), 287 ft. below the ocean level. At present the Salton Sea forms a sheet of fresh water of 440 sq. miles, 205 ft. below sea-level. If protected from further inflow, it will probably dry out in 10 years. After giving historical notes, the author shows, by a discussion of the various formulæ for evaporation, that a further study of the *evaporation* problems is needed. The Author, H. L. Heiskell, and H. O. Geren will go to Reno, Nev., for this purpose. H. B.

20. *Breathing Well on the Puy de Dôme.* **B. Brunhes** and **P. David.** (Phys. Zeitschr. 8. pp. 704–705, Oct. 15, 1907. Paper read before the Schweiz. Naturforscherversamml., Freiburg. From the French.)—The authors have found an air shaft on the Puy de Dôme, at a height of 1,410 m., which seems to be the outlet of a cave that must have inlets lower down. According to E. Sarasin, the ionisation of the air at the mouth of such wells should be greater when the air current through the well is directed outward than when directed inward. Preliminary observations by the authors with Elster-Geitel apparatus showed that the ionisation at the mouth was greater than that of the surrounding atmosphere in winter, but of the same order as that of the air in summer. The well did not appear to change the direction of its air current with the barometer as is usually assumed (air is said to be forced out at high barometer), but appeared to have a yearly (seasonal) period. Temperature observations by registering thermometers confirm this assumption. The issuing air-current had a steady temperature of + 4·1° C. in Jan. and Feb., 1906, when the air about was at —16° with snow on the ground. In March and April the temperature of the issuing air began to fluctuate slightly during the course of a day; in May it varied between + 4° and + 7° C., and the direction of the current was once reversed; these reversals—presumed from the temperature records—became regular every day in June. The barometer changes did not affect the direction of the air current [compare Abstract No. 584 (1907)]. H. B.

21. *Variation of Atmospheric Precipitation with Altitude on Mont Blanc.* **P. Mougin.** (Houille Blanche, 6. pp. 222–224, Oct., 1907. Paper read before the Assoc. franç. pour l'avancement des Sciences, at Lyons.)—The Re-afforestation Service of the Savoy have placed a number of isolated rain, or rather snow, gauges on the south-east flank of Mont Blanc for the purpose of studying the precipitation at various altitudes. The gauges, devised by J. Vallot, are specially designed to meet the requirements of a precipitation which is generally in the solid form but with a proportion of rain increasing as the bottom of the valley is approached. Each apparatus consists of a zinc cylinder 20 cm. diam. and 2 m. high. At the upper end of this is a truncated cone of zinc, the smaller base being 8 cm. diam. and supporting another

cylinder, 10 cm. high, 8 cm. diam, with perpendicular sides and sharpened edges. The lower end of the large cylinder ends in an inverted cone, terminating about 4 cm. from the bottom of a collecting vessel. Experiments with terebenthine as a protective surface-layer (to hinder evaporation) having given poor results, vaseline oil was substituted, and proved satisfactory. The gauges were placed at various points not over 5 km. distant altogether. The following table of the quantity precipitated (as water) at the various stations for three periods between 1902 and 1905 shows that there is a very pronounced maximum of the precipitation at the plateau des Rognes station, at 2,550 m. (The values are only relative since only 55·6 to 68·9 per cent. of the actual precipitation is measured, owing to evaporation) :—

Stations.	Altitude in Metres.	Depth of Precipitation Layer as Water.		
		Oct. 1, 1902, to Sept. 30, 1903.	Oct. 1, 1903, to Sept. 24, 1904.	Sept. 25, 1904, to Oct. 3, 1905.
		mm.	mm.	mm.
Les Houches (hameau de Pont)	1,010	481·9	463·2	899·8
Baraque inférieure de la Greaz	1,540	492·5	(*)	1,018·8
Barraque en bois	2,100	319·4	(*)	1,308·8
Plateau des Rognes...............	2,550	1,848·9	1,755·7	2,041·5
Barraque de Pierre-Ronde......	2,850	448·1	531	782·4
Laboratoire de Tête-Rousse ...	3,185	368·2	377·4	492·9

* Gauges destroyed by avalanche.

At the Les Houches station (1,010 m.) the proportion of the precipitation which fell as snow to the total precipitation was, for the above three periods, 15·55, 27·77 and 7·42 per cent. respectively. Pheriometric observations at the highest station (Tête-Rousse) were started in 1905, but a sufficient number of results have not been obtained to make them worth discussing. L. H. W.

22. *Propagation of Earthquakes: Interpretation of Seismic Diagrams.* **G. B. Rizzo.** (Accad. Sci. Torino, Atti, 42. 15. pp. 632–649, 1906–1907.)—In this, which is the second memoir [see Abstract No. 1826 (1906)], the author first considers the propagation of those waves to which are due the phases known as P and S of earthquake oscillations, that is, the preliminary phases; the principal phase, denoted by L, coming later. He discusses the calculation made by Omori and Mamura of the velocities of these waves at different distances from the origin, based on observations made in Europe, of the vibrations due, at a distance of some 10,000 km. from the point of origin, to the great Japanese earthquake of 1900. He considers also Benndorf's tables compiled from Rudolph's observations on the earthquake of Ceram. Benndorf's tables of the velocities of propagation are found to agree fairly well with those of other observers up to distances not exceeding 18,000 km., but beyond that give too high values for the velocities. He also compares the above tables with those of his own observations on the Calabrian earthquake of 1905. Next follows a consideration of the important question whether the preliminary oscillations are propagated along the earth's surface, that is, along the great circle connecting the point of observation with the "epicentre"—the point on the surface vertically over the actual centre of disturbance or "hypocentre"; or, on the other hand, are they propagated along the shortest route connecting the hypocentre with the point of observation through the interior of the earth? Such shortest route depends on the function expressing the earth's density in terms of the distance from the centre, which is unknown, and on the index of refraction which determines the change of direction and of speed that the wave undergoes in passing from one stratum to another of different density. The author gives his opinion very strongly in favour of the great circle path, on the ground that the other view would require us to make very improbable hypotheses concerning the state of the earth's interior. He then considers the observations of the Calabrian earthquake as bearing on the question whether the oscillations are longitudinal or transverse, and in the latter case vertical or horizontal, and concludes: (1) That at the epicentre there is always a vertical component, the acceleration in which may exceed that due to gravity; (2) that after violent earthquakes there are, even at great distances from the point of origin, periodic oscillations of level affecting astronomical observatories; (3) that instruments such as the horizontal pendulum of Vicentini, and Wiechert's vertical pendulum are adapted to register the vertical oscillations, while the horizontal ones are due to periodic variations of the surface inclination. The memoir concludes with a notice of the works of Lamb and Rayleigh on this subject, according to which a disturbance due either to external or internal causes may produce on the surface of a homogeneous elastic solid oscillations of small depth compared with the distance from the origin—with respect to which point annular undulations occur of three forms, the first being longitudinal, the second equivoluminal waves, and the third those known as Rayleigh's waves. Lamb's mathematical theory, the author says, agrees very accurately with the observed facts. S. H. B.

23. *Cause of Earthquakes.* **T. J. J. See.** (Amer. Phil. Soc., Proc. 45. pp. 274–414, Oct.–Dec., 1906.)—It is impossible to more than summarise here even the author's own summary of 24 paragraphs of conclusions. It is considered proved that no violent earthquake shock could ever arise as the result of continuous deposition of sediment on the continental shelves; that the great depth (10–20 miles) at which world-shaking earthquakes originate, and other correlated facts, disprove the theory that earthquakes are due to fracture and slipping of rocks; and that therefore earthquakes must depend upon explosive forces within or just under the earth's crust; that steam is the cause of volcanic eruptions and of earthquakes; that when the subterranean steam pressure becomes great enough to shake the earth's crust, it naturally moves at the nearest fault line, where the rocks are broken, but the movement observed is the *result*, not the *cause* of the earthquake. Reference is made to the memoir of Tarr and Martin (Geolog. Soc. of America, Bull. 17. May, 1906). [See also Abstracts Nos. 1828, 1880 (1906).] L. H. W.

24. *Temperature, Secular Cooling and Contraction of the Earth.* **T. J. J. See.** (Amer. Phil. Soc., Proc. 46. pp. 191–299, April–Sept., 1907.)—In this comprehensive monograph historical considerations and the theory of earthquakes which was held by the ancients figure very largely, for which the original should be referred to. In other directions the work forms a publication *in extenso* of the author's views previously disclosed in Abstract No. 1880 (1906) and the preceding Abstract. It is impossible here to do more than indicate the sectional headings and refer to a few of the more noticeable conclusions. The main sections deal with: (1) *Temperature and internal state of the Earth.*—Probable law of temperature within it, Hypothesis of deep-seated movements contradicted, Why the earth can never have tended to the tetrahedal form, Main continental and oceanic features probably due to ruptures produced when the moon was formed. (2) *Secular cooling of the Earth.*—Analytical theory of heat propagation applied, Age of earth's consolidation calculated by the Fourier-Kelvin method and by Fisher's method, Remarkable agreement of these results, Results of researches on radium. (3) *Age of consolidation of the Globe and the second approximation to the law of temperature near the surface.*—Approximation to actual law of temperature, Methods for determining depth to which cooling has extended, Theories held by the ancients.

Using Ritter's formula for the condensation of a gaseous sphere ("Anwendungen der Mechan. Wärmetheorie"), with Helmert's value for η, the temperature at the centre of the earth is 83,619° F., and the following table gives the density, pressure, and rigidity (on the author's monatomic hypothesis [Abstract No. 1880 (1906)]), as well as the temperature at various distances from the centre, the average sp. heat of the earth's matter being taken as 0·2; the results being calculated on an elliptical distribution of temperature within the earth :—

Radius.	Density, Water = 1.	Pressure in Atmos.	Theoretical Rigidity due to Pressure, that of Ni steel = 1.	Temperature.
1·0	2·55	1	0·0000	0·0°
0·9	3·75	198,760	0·19876	33,500
0·7	6·21	842,921	0·84292	59,200
0·5	8·46	1,710,730	1·71073	72,500
0·3	10·12	2,521,620	2·52162	80,000
0·1	11·07	3,050,870	3·05087	83,500
0·0	11·21	3,135,727	3·13573	83,600

This average rigidity of all the earth's matter is calculated to be over 1 million atmos., taking no account of the increase of rigidity due to the solid crust. The matter in the interior, in confinement under great pressure, behaves as an ælotropic elastic solid, with a rigidity depending on the pressure : it follows that no currents can circulate at great depths, and hence that the views of some geologists, that liquid lava is extruded deep down, are untenable ; as also is Chamberlin's supposition that volcanoes had their start at a depth of 1,200–1,500 miles. The origin of the principal oceanic basins is ascribed to the detachment of the main body composing the moon from the vast depression now occupied by the Pacific Ocean. The age of the earth estimated by Kelvin's method (taking V = 7,000° F. as the initial temperature) is roughly 100 million years. Since, however, the experiments of Rücker and Roberts-Austen have shown that basalt fuses at 1,688° F., it is concluded that the surface temperature of the earth has never much exceeded 2,000° F. Taking this as a mean temperature, V in Kelvin's equation becomes 4,000°, in which case the age of the earth is 33 million years ; and for V = 2,250° only 13 million years ; for V = 2,000° but 8·8 million years : the latter is taken as the most probable value and one that agrees with the duration inferred from the theory of the the sun's heat. By Fisher's method, assuming an inert substratum, the thickness of the crust must lie between 16·8 and 21·9 miles ; taking 17·5 miles as indicated by the San Francisco earthquake, the age of the earth is found to be 5¼ million years ; or 8¼ million years assuming a thickness of crust of 22 miles. From Milne's results the cooling, it is considered, has not extended below a depth of 40 miles (1/100 of earth's radius). Finally, earthquakes, volcanoes, mountain formation, seismic sea waves, are all referred to a common cause, viz., the development of steam beneath the earth's crust, owing principally to the secular leakage of the ocean bottoms.

L. H. W.

25. *The Solar Radiation to the Earth, taking into account the Absorption of Heat by the Atmosphere by Lambert's Law.* Part I. **F. Hopfner.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2a. pp. 167–234, Feb., 1907.)—After an introductory sketch of the bibliography of the subject, the author discusses the various aspects of the problem, and the choice of independent variable. He takes as the most important quantity to be found from a meteorological standpoint the mean average of heat radiated to unit surface in a given latitude in a given time. The following sections deal in turn with the distribution of solar radiation at the earth's surface; Lambert's law, and special forms of the same; the distribution of solar radiation at the earth's surface as affected by atmospheric absorption; Zenker's and Angot's investigations; and lastly, the author's fourth form of Lambert's law. The special feature of this last form is, that, like a Fourier series, it enables the radiation-curve for a given latitude to be expressed as the resultant of an infinite number of waves. This mode of representation is useful for studying those variations in the radiation curve which depend on the elements of the earth's orbit. The fourth form of Lambert's law also enables the integrals concerned in the present discussion to be reduced to their simplest form, and therewith the author's task is concluded so far as meteorological considerations are involved. The remaining portion of the solution, which is purely mathematical, dealing with the solution of the integrals and numerical calculation of results, is reserved for a future communication. A. E.

26. *Total Solar Eclipse Aug.* 30, 1905. **N. Donitch.** (Acad. Sci. St. Pétersbourg, Bull. 15. pp. 661–689, Nov. 1, 1907.)—The Report of the Astronomical Expedition of the St. Petersburg Academy. Two of the observers were stationed at Alcala de Chisvert, near Castellon, in Spain, and two at Aswan in Egypt. The Spanish party secured three spectrograms, and also two photographs of the corona, clouds having intervened after the first 40 seconds of totality. The Aswan party was equipped only with a coronograph, with which four plates were obtained, the sky being clear throughout the eclipse. In thus dividing the expedition into two branches, the director was animated by the hope of obtaining a stereoscopic view of the corona by combining pictures taken under similar conditions at two stations widely apart. This hope was frustrated by the accidental displacement of the coronal image on the Aswan plates by some unknown cause; these plates, however, could be used for purposes of general comparison. The most successful spectroscopic plate was one taken at the beginning of totality with a spectrograph furnished with an objective prism, the exposure commencing a second or two before totality, and lasting 5 or 6 seconds. Wave-lengths of 111 chromospheric lines measured upon it are tabulated in the paper. The spectrum consists of a superposition of the spark spectra of the following elements: H, He, Ca, Sc, Ti, Cr, Fe, Sr, Y, Ba. The thicknesses of the corresponding gas-layers in the chromosphere (which are also tabulated) do not diminish regularly with increased atomic weight, owing to strong local perturbations. The presence of the following

elements is also doubtfully indicated in the chromosphere: Co, Zr, Eu, and perhaps Ge. A few lines remain unidentified. The same plate reveals 5 prominences, which are visible on the calcium H and K lines, and on the hydrogen lines H_β H_γ H_δ H_ϵ. Two of them are also visible on the arc 447·185 $\mu\mu$ of helium. That having the greatest height, 78,700 km., was situated in the north-east quadrant in latitude 26°. No trace of the coronal rings was found on the plate, though they were intense during this eclipse. The spectrum of the photosphere is reduced to a very narrow riband. Another spectroscopic photograph was taken during totality with a slit spectrograph of high dispersion, with the object of measuring the coronal rotation; but clouds cut short the exposure, and no trace of a coronal line was obtained. Several chromospheric lines between λ421 and λ429 were recorded however, and have been measured. The measures show that the displacement in this region of the spectrum corresponding to the rotation of a point on the sun's equator is 0·008 $\mu\mu$. The author infers that the measures would have sufficed to indicate at least the order of the coronal rotation. For the purpose of studying in detail the form of the coronal streamers, two of the coronograph pictures taken at Alcala, and one of those taken at Aswan, were reproduced on twice the original scale. A comparison leads to the conclusion that the corona presented the same aspect at both stations, and was of the characteristic type of an epoch of maximum solar activity. The most remarkable feature is a fan-like group of streamers above the great prominences on the eastern limb. A jet near the South Pole is remarkable as being convex towards the sun's centre. The final portion of the Report contains an investigation of the sun's repulsive force by Brédikhine's method applied to the enlarged coronal photographs above referred to. In this method the hyperbola is sought which best fits the form of a selected coronal jet, and the force required to propel a particle along this hyperbola is then calculated. Assuming an initial velocity of 300 km. per sec., the author's results for five different jets give, roughly speaking, an average value for the repulsive force equal to about half the force of solar attraction. By assuming smaller initial velocities the results can be made to fit Brédikhine's view of the analogy between the corona and comet tails of the second type. The results are also shown by von der Pahlen to be compatible with the conclusion that these coronal jets (with perhaps one exception) might be trajectories of particles acted on only by Newtonian attraction, and projected from the sun with velocities such as are observed in prominences. A. E.

27. *Observations ot Jupiter during the Apparition of* 1906–7. **T. E. R. Phillips.** (Roy. Astronom. Soc., Monthly Notices, 67. pp. 522–527, June, 1907.)—The instrument used was a 9¼-in. equatorial reflector. Atmospheric conditions were unusually unfavourable. The most notable surface change as compared with last apparition was the great development of the north equatorial belt. It had been very feeble early in 1906. The first sign of change was observed by Denning, who in April found a very dark spot near the north temperate belt from which dark matter passed in a slanting streak to the north equatorial belt. The great south tropical disturbance was again an interesting feature. Its dark matter extended over nearly 60° of longitude, diminishing later to 47°. The preceding and following white spots were still conspicuous. The old Red Spot was plainly seen on several occasions, generally as a faint elliptical grey shading lighter in the middle. The bay or hollow in which it lies was well defined except in the earlier months,

Some conspicuous colour changes took place on the planet. The north equatorial belt, which was bluish in spring before conjunction, was red in Aug. A few months later the central portion had faded, and the north edge become grey. The south equatorial belt, which during the previous apparition had been purplish, was usually wanting in colour. The whole North polar region, which had been reddish in 1895–6, was commonly bluish-purple. The author made it his chief endeavour to secure eye-estimations of transits of spots, &c., over the central meridian, with a view to determining the mean rotation period in different latitudes. About 90 objects were sufficiently well observed to secure identity. He tabulates the deduced mean rotation periods for spots lying in the principal surface currents, the periods ranging from 9h. 55m. 10·9s. to 9h. 55m. 42·2s. The period of the south edge of the south temperature belt showed a well-established retardation of 2 or 3 seconds. The period of the Red Spot, which is notoriously variable, more than maintained its reputation; between April and Aug. the spot showed the most rapid shift in longitude hitherto recorded. Molesworth has recently put forward a theory regarding the transference of the dark matter involved in the great south tropical disturbance from one side to the other of the Red Spot. He says that the transference occurs instantaneously, the appearance being as if the neighbouring medium were incompressible, so that as soon as the dark matter enters it an equal quantity is displaced at the other side. The author's observations indicate that during the time of the planet's invisibility matter was transferred across the Red Spot in about a fortnight. The normal time corresponding to the distance would be 3 months, so that the transference, if not instantaneous, was extraordinarily rapid. The main point of Molesworth's contention is therefore, to a certain extent, supported by the observations. The motion of equatorial spots varied considerably during the apparition. There was a very large difference of rate, over 14 seconds per rotation, between the two portions of the equatorial current. A. E.

28. *Transit of Mercury, Nov.* 14, 1907. *Observations at the Nice and Bourges Observatories.* **Bassot, T. Moreux, A. de la Baume Pluvinel.** (Comptes Rendus, 145. pp. 839–843, 858–860, 861–862, Nov. 18, 1907.)—At Nice the sky was clear throughout the transit, but the images were very unsteady, rendering measures of the planet's diameter uncertain. Observations of contact and measures of diameter were made with the three equatorials (apertures 0·76, 0·40, and 0·38 m.). The greatest difference between the times of contact noted by different observers is 35 sec. for second contact and 45 sec. for third contact. The diameter measures range from 7·62″ to 10·10″ for the equatorial, and from 7·38″ to 11·18″ for the polar. But in every case measures by the same observer make the planet's equatorial diam. the greater. The observations give the following corrections to the ephemeris in *Connaissance des Temps*, −0·26 sec. and −9·1″; and the following values for the diam., 10·08″ (equatorial), 9·71″ (polar). The black-drop and a light aureole round the planet were seen both in the 0·76 m. and in the smaller instruments. Twelve photographs were obtained with the heliograph by Mme. Chrétien. Pluvinel examined the solar spectrum close to the limb of Mercury in order to search for any modification of aspect which might be produced by a planetary atmosphere. The B group and other bands were observed visually, and a number of photographic flying shots were taken at moments when the slit appeared to be tangential to the planet's disc. But no trace of modification was observed in any of the spectrum lines, either visually or photographically, though some of the photographs appeared to show the solar spectrum well right up to the edge of Mercury. During ingress search was made, with slit opened wide and set tangential to the sun, for a luminous crescent bordering the portion of Mercury's disc outside the sun. But no such crescent was visible. At Bourges, in spite of clouds, observations were possible during the greater part of the transit. An equatorial of 0·162 m. aperture and some smaller instruments were employed. Mercury often assumed a dark violet tint. A luminous aureole was seen soon after first contact, when it was comparable in brightness to the faculæ. The aureole appeared at frequent intervals throughout the transit, especially in calm moments, but was not visible simultaneously to different observers. Its relative width appeared less the larger the objective. At the beginning all the six observers saw a bright point on Mercury east of the centre; at the end it was distinctly to the west. Like the aureole, it was only visible at intervals, and its appearance did not necessarily coincide with the aureole's. These remarks apply to low powers. With a power of 325, and Mercury in the middle of the field, the bright point always appeared to the author at the centre, and was ill-defined and oscillating. The author gives strong reasons for his impression that both aureole and spot were subjective phenomena. A. E.

29. *The Canals of Mars, optically and psychologically considered.* **P. Lowell.** (Astrophys. Journ. 26. pp. 131–142, Oct., 1907).—A reply to Newcomb [see Abstract 1467 (1907)]. Lowell says that Newcomb, in discussing the diffuse border to the image of a point or line produced by telescopic aberration, has overlooked the two following facts: Firstly, that the brightness of an out-of-focus image is in inverse proportion to its area; secondly, that the eye is not equally sensitive to all colours. The effect of these two factors, according to Lowell, is to produce a curve of intensity not unlike that of the diffraction pattern for a circular aperture. He then cites as an argument against Newcomb's conclusions the sharpness of edge of the spurious disc of a star and of the surrounding rings. He also quotes some of Dennis Taylor's experiments on star discs [Roy. Astronom. Soc., Monthly Notices, 54. pp. 67–84, 1893] as giving results in contradiction to Newcomb's. He mentions that, in the clear air of Flagstaff, the shadows of Jupiter's satellites appear in the telescope so sharply edged as to look like black spots in the focal plane. Ink lines on paper viewed through the telescope at great distances appear as sharp as when seen close with the naked eye. On the other hand, faint shadings are seen on Venus and Jupiter totally differing in appearance from the "canals" of Mars. Referring to alleged discrepancies in the Flagstaff drawings, Lowell explains that none such are found between independent observers working consecutively. Such discrepancies as exist are mainly due either to change in atmospheric conditions or to seasonal change in the planet itself. He says Newcomb placed the disc used in his sketching experiments at such a distance as to subtend less than a third of the diameter of Mars as seen at Flagstaff during this opposition. For the copy of this disc reproduced in Newcomb's article the proper distance for viewing is only 2·7 m. (8·7 ft.), and the discontinuities in the lines are then easily seen. Even at the distance 30·8 ft., corresponding to that at which the original was sketched, the greater part of the lines reveal their composite character. Further, in the original experiment the disc was viewed by transmitted light, whereas in practice Mars is seen by reflected light. Experiments on the detection of irregularities or breaks in lines were made at Flagstaff through a 4-in. telescope upon ink lines ruled on paper set up at a distance of 585 ft. It was found possible to perceive: (1) A difference in thickness corresponding to 3 miles on Mars; (2) a break corresponding to over 18 miles (29 km.) on Mars; (3) a line of width less than 2 miles (3 km.) on Mars. *Note on the preceding paper.* **S. Newcomb.** Newcomb, replying, cannot concede that either of the two factors mentioned above has been omitted by him in such a way as to change the character of his results. These results are based on light between λ5614 and λ5894—a region in which the intensity is nearly uniform. He remarks that Lowell seems to overlook the difference between the shading off of dispersed light around the sharpest image of a luminous point, and the diffusion by aberration of the image of a black point on a bright background. He asserts that Lowell's useful telescopic observations of artificial dark lines, and the citations from Dennis Taylor, afford excellent illustrations of the process of visual inference mentioned in his paper. To correct misapprehension, he adds that his argument is not directed to prove that the canals of Mars are not fine dark lines, but only to show that there are a number of other features which an observer may train himself into interpreting as fine dark lines, and that the actuality on Mars may therefore differ from the observer's inferences. **P. Lowell.** Lowell (in reply to Newcomb's note) remains unconvinced, and remarks that it is precisely to light between λ5614 and λ5894 that Taylor's experiments referred. He responds to a challenge to revise Newcomb's computation of the area of the image of the canal system on the retina. The breadth of the canals is too small to be sensible, and can only be got by comparison of intensity with the micrometer thread and by other experiments, giving 15 miles as the average maximum width. From the zonal numbers and breadth he calculates that the actual area on the planet is one-tenth of the surface. The probable retinal area he estimates as twice this value, assuming that when a single cone is struck it responds *in toto* to the stimulus, gauging size solely by intensity. If the cone does not respond *in toto* the area diminishes to the first-named value as its limit. A. E.

30. *Transits of Mercury across the Sun's Disc, and in particular that of Nov.* 14, 1907. **G. Bigourdan.** (Comptes Rendus, 145. pp. 609–613, Oct. 14, and pp. 647–654, Oct. 21, 1907.)—The author gives a very clear and systematic account of the phenomena to be looked for on the occasion of a transit, discussing them in turn in the order in which they would become visible to the observer, and tendering practical advice respecting the utility of the various observations and the most suitable instrumental equipment to provide. The points discussed include the visibility of Mercury outside the solar disc, with or without a spectroscope; the horns cut off on the sun at internal contact; the "black drop," and the effect of dark glasses, magnifying power, &c., on judgment of the times of contact; the measurement of the distances between the limbs of Mercury and the sun; the form of the planet's disc; the question of satellites; the occultation of sun-spots and faculæ by Mercury; the darkness of the planet's disc; the determination of the diameter; and the appearance of the historic annulus and bright spot.

A. E.

31. *Paulsen's Résumé of Recent Theories of Polar Lights.* **P. H. Dike.** (Terrestrial Magnetism, 12. pp. 84–86, June, 1907.)—The article is an abstract of Paulsen's paper, "Sur les Récentes Théories de l'Aurore Polaire" [Acad.

Sci. Kopenhagen, Bull. No. 2. pp. 109–144, 1906]. The principal theories of the aurora published since 1896, namely, those of Birkeland, Arrhenius, and Nordmann, are first passed in review, and the flaws in each pointed out. All agree in considering the auroral rays as a luminescence produced by the absorption of kathode rays in the atmosphere, but none explain all the phenomena. A new theory advanced by Paulsen himself is next described. Auroræ are divided into two classes: (1) Those without a structure of rays, quite tranquil, slow moving and producing a steady light, and in polar regions producing little or no magnetic disturbance; (2) those of a radiate structure. Auroræ of the second class in general are subject to active movements, and may be of great height and very narrow. The lower part is always the most luminous. They are closer to the earth than those of the first class, and affect the earth's magnetic field strongly. They have the properties of kathode rays, and their spectrum contains the kathode spectrum of nitrogen. Measurements of their height have shown that they cannot be less than 400 to 500 km. above the earth, at which height the air would be too rarefied to permit discharges or electric luminescence. The fundamental hypothesis is then put forward that the cause of the aurora lies in an immense ionisation of the upper layers of the atmosphere above the zone of maximum auroral frequency, of such sort that the alteration of the air renews itself each day, beginning at the limits of the atmosphere. The kathode rays from the sun following the magnetic lines of force in the regions of the atmosphere will, in the neighbourhood of the magnetic poles, be drawn into the atmosphere, causing during the day an enormous ionisation and a negative charge of the upper layers of the atmosphere. A great expansion of these upper layers is thereby produced, so that they rise far above the levels that they ordinarily occupy. This negative charge increases until it is balanced by the emission of kathode rays into space. This mixture of negative corpuscles and molecules of air is called auroral material. The motion of the particles and the emission of kathode rays lead to perpetual variations of potential of different parts of the mass, and the radiation being under the control of electric forces, constantly varying, will not necessarily follow the lines of force of the earth's magnetic field. W. Huggins and Lady Huggins have shown that the strong radiation of radium in a gas produces a luminescence giving the spectrum of the surrounding gas. It is suggested that the presence of nitrogen lines in the auroral spectrum may signify that the light is of similar origin to the radium luminescence. The constant changes in form of the aurora are explained by the variations of potential. The greatest ionisation will be where the sheet of magnetic lines of force directing the kathode rays bends down into the atmosphere, giving rise to the auroral arcs, which are generally perpendicular to the magnetic meridian. The radiate structure is due to the kathode rays emitted by the auroral material following the lines of force. The auroræ of the first class being insulated by layers of air of great rarefication can produce no magnetic effect, but the radiate auroræ, by bringing the great masses of electrified matter in communication with the layers of air where electric currents can exist, produce great oscillations in the intensity of these currents, and disturbances of the magnetic needle. In lower latitudes the appearance of an aurora is probably caused by the transportation of auroral material by winds in the upper layers of the atmosphere. In transport it cannot remain insulated from the lower layers, which are good conductors, and thus magnetic disturbances always accompany auroral displays in lower latitudes. This hypothesis explains the diurnal and undecennial periods of the aurora, but makes the annual maximum fall at the equinoxes rather than in winter.

In lower latitudes rays shooting upward to heights over 1,000 km. are frequent—a fact which cannot be explained unless the rays carry with them a material which of itself produces the light, since such altitudes are much beyond the limits of our atmosphere. A. E.

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32. *Micrometer for Photographic Plate Measurement.* **A. Wolfer.** (Zeitschr. Instrumentenk. 27. pp. 297–301, Oct., 1907.)—Description of a new micrometer made by Toepfer, of Potsdam, for measuring rectangular co-ordinates on photographic plates. C. P. B.

33. *Theory of Ship-resistance.* **H. Lorenz.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 1824–1829, Nov. 16, 1907.)—A mathematical treatment.

34. *Mortar and Concrete Mixtures.* **W. Challoner.** (Engineer, 104. pp. 243–244, Sept. 6, 1907.)—Gives results of extensive tests of mortars and cements, the mixtures being cement and sand; cement, trass, and sand; trass, lime, and sand; with stone or gravel; the cost of materials is also throughout considered. The paper does not lend itself to useful brief abstraction. It is also stated that tests have proved the great advantage of using trass mixed with cement in sea-water work. F. R.

35. *Cold Waves and Frost in the United States.* **E. B. Garriott.** (U.S. Weather Bureau, Washington, Bull. P. [Publication No. 355. pp. 7–22 with 328 charts], 1906.)

36. *Climatology of the United States.* **A. J. Henry.** (U.S. Weather Bureau, Washington, Bull. Q. [Publication No. 361. pp. 7–1006], 1906.)

37. *Paths of the Meteors of Jan. 19 and June 29, 1905.* **G. v. Niessl.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2a. pp. 61–107, Jan., 1907.)—[See also Abstract No. 872 (1906).]

38. *Mira Maximum,* 1906–7. **Nijland.** (Astronom. Nachr., No. 4183. p. 113, June 14, 1907. Nature, 76. p. 259, July 11, 1907.)—From series of observations made during period 1906, July 25, to 1907, March 4, the epoch of maximum brilliancy was determined to be on Dec. 7, the magnitude being then 2·0. Preceding minimum occurred on Aug. 7, and the last maximum on 1906, Jan. 3, giving a period of 338 days. C. P. B.

LIGHT.

39. *Abnormal Dispersion in Crystals at Different Temperatures.* **J. Becquerel.** (Comptes Rendus, 145. pp. 795–798, Nov. 11, 1907.)—From experiments on four bands of tysonite at ordinary temperatures and at liquid-air temperatures the author calculates the total charge and total mass of the electrons per unit volume concerned in the phenomena. This leads to the conclusion that either the charge e is less than that considered to be the atom of electricity, or (which is more probable) not all the molecules simultaneously participate in the absorption. [See also Abstracts Nos. 1158 and 1346 (1907).] E. H. B.

40. *Some Physical Properties of Colloids.* **N. Stücker.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2a. pp. 771–783, April, 1907.)—An account of measurements on the electrical conductivity and optical behaviour of colloids in the solid and dissolved conditions. When deposited on glass in a layer 0·0008 mm. thick the colloidal metal had a conductivity of the order 10^{-11}. Optical measurements were made on the elliptical polarisation at the surface of solid colloids and the absorption in solid and dissolved colloids. The refractive indices, reflecting powers and extinction coefficients, were then calculated from the observations, and tables and curves give the results found. In the curves, which show the variation of extinction coefficient with wave-length, those for silver in the solid and liquid states are somewhat similar, whereas those for gold exhibit a large difference. G. E. A.

41. *Artificial Dichroism of Blue Rock-salt.* **H. Siedentopf.** (Phys. Zeitschr. 8. pp. 850–851; Discussion, pp. 851–852, Nov. 15, 1907. Paper read before the 79 Naturforscherversamml., Dresden.)—Blue rock-salt, when compressed in a direction perpendicular to a hexahedral surface, becomes dichroitic, the dichroism being confined to the blue and violet colouring of the NaCl, whether the natural or artificially coloured crystal is used. Specimens do not exhibit dichroism when stressed in other directions. Ultramicroscopic research shows further that the phenomenon is not connected with the relative distance, nor with the size of the visible coloured particles. In the *discussion*, an explanation is sought in the change of shape of the particles from spheres into ellipsoids. G. E. A.

42. *Method of correcting the Astigmatism of Double Refracting Prisms.* **C. Tissot** and **F. Pellin.** (Comptes Rendus, 145. pp. 866–867, Nov. 18, 1907.)—Double refracting prisms have the serious defect of distorting the image. In a Nicol's prism, for instance, rays entering at different angles of incidence have different lateral deviations, and hence the image must be distorted. The authors have found that this defect can be completely remedied by placing a cylindrical lens of suitable focal length in front of the nicol, the axial section of the lens coinciding with the symmetrical plane of the prism. This simple device greatly improves the image in those cases where an eyepiece is used with the nicol. A. R.

43. *Gibbs' Geometrical Method of discussing the Phenomena of the Reflection of Light.* **A. W. Ewell.** (Amer. Journ. Sci. 24. pp. 412–418, Nov., 1907.)—A geometrical method of representing and interpreting the phenomena of the total and the metallic reflection of light, due to Gibbs, is described. The reciprocals of the velocities of light in the two media between which reflection occurs, and also their components parallel and perpendicular to the surface, are represented by lines. These lines are so chosen that very simple geometrical quantities represent Fresnel's laws. These laws, together with the ordinary laws of reflection and refraction, are assumed. The way in which the variables involved alter with changes in the angle of incidence and the optical constants of the media, are shown at once by the diagram. A. R.

44. *Production of Images on Photographic Plates by the Action of Vapours of dissolved Mercuric Chloride. Case of Reaction Radiation.* **K. Kof** and **H. Haehn.** (Zeitschr. Phys. Chem. 60. pp. 367–383, Aug. 6, 1907. Pharmazeut.-chem. Laborat. d. Univ., Königsberg.)—On developing a sensitive plate after it has been exposed close to the surface of a solution of mercuric chloride in water, alcohol, benzene, or toluene, a white image is obtained. The authors show that this effect may be regarded as a negative catalysis, the exposed parts of the plate being more slowly developed than the protected parts. Hydrogen peroxide vapour acts on a photographic plate as a positive catalyst, and images obtained by its means are obliterated on exposure to the vapour from mercuric chloride solution, and *vice versâ*. No effect is produced on a plate exposed closed to a mercuric chloride solution saturated with sodium chloride, the mercuric chloride being then probably in the form of a complex. Aqueous arsenious acid has a weak negative catalytic action. A plate exposed close to the surface of stannous chloride solution is unaffected, but, when laid on the top of a beaker in which the reaction $2HgCl_2 + SnCl_2 = 2Hg + SnCl_4$ is taking place, the plate is rapidly affected, subsequent development giving rise to a dark image. No effect is produced when the vapour above the liquid is continuously removed during the exposure of the plate. Mercuric chloride solution is reduced by the escaping emanation, which does not, however, consist of stannous chloride. T. H. P.

45. *Colour Photography.* (Nature, 76. p. 642, Oct. 24, 1907.)—Description of the Warner Powrie plates; triple-coloured lined screens obtained by a method of printing lines and spaces in bichromated gelatine in three successive coats dyed in the respective three colours, and coating the screen with sensitive emulsion. Exposure is from the back. With linear screen it is easy, interposing a thin film of celluloid and using reflectors, to prevent any part of the printing paper from remaining unaffected by light, and therefore to use bleaching out paper ("Uto") for printing purposes. A. D.

46. *Relation between Absorption Spectra and Optical Rotatory Power.* Part II. *The Tartaric Acids.* **A. W. Stewart.** (Chem. Soc., Journ. 91. pp. 1537–1543, Sept., 1907.)—The spectra of the two active forms of tartaric acid are identical; the spectrum of mesotartaric acid shows greater general absorption than that of the active isomerides. True racemic acid is present in highly concentrated solutions but breaks down as they are diluted; the racemic form has a greater general absorption than the active forms. [See Abstract No. 831 (1907).] D. H. J

47. *Absolute Distribution of Intensity in the Continuous Background in the Spectra of the Alkali Metals, and the Radiation of the Hefner and Osmium Lamps.* **F. Leder.** (Ann. d. Physik, 24. 2. pp. 305–325, Nov. 12, 1907. Extract from Dissertation Kiel.)—The author has measured the absolute distribution of intensity in the continuous background which is always present in the spectra of the alkali metals by direct comparison with an osmium lamp. He finds that the continuous spectrum is directly connected with the secondary series of lines in these spectra, although the intensity is abnormally increased in certain regions by the halo due to the lines of the principal series. Measurements are also given of the radiation of the Hefner and osmium lamps by direct comparison with an absolutely black body.

E. C. C. B.

48. *The Displacement of Spectral Lines.* **J. Larmor.** (Astrophys. Journ. 26. pp. 120–122, Sept., 1907.)—Humphreys' paper on the pressure-shift of spectrum lines [see Abstract No. 1814 (1907)] gives the data for a scrutiny of the origin of the pressure-shift. The phenomenon is probably describable as a density-effect, the effect of increasing the density being to increase the inductive capacity of the medium, or, in other words, to diminish the effective æthereal elasticity which propagates the radiation. This is the averaged result; each molecule individually, through the agency of its plastic field of force or æther-strain, provides a yielding region in the æther in which the effective stiffness is diminished. The elastic energy which maintains the free vibrations of a radiator is located in its field of force in the adjacent æther, and by dynamical principles any loosening of the constraint in that field such as an adjacent molecule would produce, must, in general, tend to increase the free period. Now the change in free period due to a slight change of constitution of the vibrating system can be estimated by calculating the altered kinetic and potential energies of the type of vibration on the assumption that the type is not altered. Suppose the vibration molecule to be situated in the centre of a sphere of free æther, beyond which the molecularly constituted gas is taken to be smoothed out into a uniform medium having the inductive capacity K of the gas. The type of vibration being retained as before, its kinetic (magnetic) energy is not thereby altered from what it would be *in vacuo*, but its elastic (electric) energy is altered in the ratio K^{-1} wherever K differs from unity. If the vibrating æther field is that outside a concentric spherical surface of radius a and the electric field falls off with distance according to the law r^{-n}, multiplied by a function of direction, then the static energy in it measured from outside up to a concentric spherical surface of radius c, will be proportional to—

$$\int_c^{\infty} r^{-2n} 4\pi r^2 . dr, \quad \text{or} \quad \frac{4\pi}{2n-3} c^{-2n+3}$$

If therefore the region beyond a distance c, equal to ka, is filled with material of inductive capacity K not much different from unity, the total static energy of the vibration is altered in the ratio of—

$$a^{-2n+3} - c^{-2n+3}(1 - K^{-1}) \quad \text{to} \quad a^{-2n+3},$$

that is to say, of $1 - k^{-2n+3}(1 - k^{-1})$ to 1; the frequency of the vibration is increased as the square root of this. For air at atmospheric pressure $K = 1·0006$ and the proportionate change of wave-length is about 10^{-6}. If the vibrator operates as a simple Hertzian doublet $n = 8$, which makes k about 8·5. In a gas at atmospheric pressure the molecules are spaced at a mean distance of very roughly 10 times their diameter, and if $n = 8$, only 1/27 of the energy of one of them is beyond three molecular radii from its centre. It is therefore not unreasonable to replace the influence of the discrete distribution of gas molecules by that of a uniform averaged medium extending to about eight molecular radii from the centre of the vibrator. However, it is not possible from the data to say more than that the delectric influence of the neighbouring molecules is a *vera causa* of the right order of magnitude. If $n = 4$ the value of k would be about 8·5 which may be just barely permissible, but if $n = 5, k > 2$ which is impossible. Moreover, if n were not 8 the effect would not be proportional to the density. There is therefore some presumption that the free vibration corresponding to each spectrum line is (except close up to the nucleus) of the type of a Hertzian doublet. The author points out that the fact that the shift has not been observed in band spectra may be due to the vibrator being a molecule and that the field of energy of each molecule is more concentrated into the region between its atoms; a higher value of n would make the difference. The one-sided broadening of the absorption bands of mercury vapour [see Abstract No. 1505 (1907)] and its abolition by the admixture of a foreign gas may be explained by the tendency to condensation in the pure vapour, proceeding to an equilibrium when the formation of loose molecular aggregates is balanced by their destruction by collisions. The molecules in such loose aggregates would, owing to their slight mutual influence, vibrate in longer periods and give rise to the displaced part of the bands. The average amount of this incipient aggregation would be much diminished by the admixture of a neutral gas. [See also next Abstract.] E. C. C. B.

49. *The Cause of the Pressure-shift of Spectrum Lines.* **W. J. Humphreys.** (Astrophys. Journ. 26. pp. 297–298, Nov., 1907.)—In reference to Larmor's paper [see preceding Abstract] the author points out that it appears safe to assume that the period of any vibrating body is dependent upon the elasticity both of the body itself and of the surrounding medium which takes up the vibrations, and therefore a change in either of these elasticities will change its period. If the inertia remains constant $et^2 = k$ (constant), where e is the elasticity and t the period. In the case of a spectrum line any decrease in e produces a corresponding increase in λ^2, and further, the greater λ is the less its increase necessary to produce a given increase in its square. Assuming the Hertzian doublet and that its pressure-shift is due to an increase in the specific inductive capacity of the surrounding medium, it would be expected that increase of pressure would produce (*a*) a shifting of the entire line to the red, (*b*) the increase of λ^2 as a linear function of the pressure. It is found, however, that the line broadens to the violet as well as to the red, but the latter predominates; the change in λ is too small to test whether the increase of λ^2 is a linear function of the pressure. Again, it would be expected that the greater the inductive capacity of the gas used the greater would be the shift for a given pressure. This conclusion, owing to want of knowledge, has not yet been established. Lastly, so far as the experiments show at present, the shifts appear to be greater the smaller is λ, which is the opposite of what would be expected. Possibly, however, these and all other objections would be met by properly distributing between the interior of the atom and the surrounding medium the elasticity that determines the period of any line. The author doubts whether such a complex problem can ever be made to fit experimental results as well as do magnetically-interacting Saturnian atoms. He does not agree with Larmor in calling the effect a density-effect, but prefers to consider it a proximity-effect which refers to compactness of numbers without regard to their individual masses, and therefore while proportional to pressure is different from density. E. C. C. B.

50. *The Difference in Wave-lengths of Titanium* $\lambda\lambda = 3900$ *and* 3913 *in Arc and Spark.* **N. A. Kent** and **A. H. Avery.** (Amer. Acad., Proc. 43. No. 11. pp. 353–361, Nov., 1907.)—In a previous paper [see Abstract No. 1864 (1905)] some variations with the electrical conditions of the discharge were noted in the wave-lengths of certain spark lines of Ti, Fe, and Zn. These results were criticised by Keller, who suggested that they were due to a want of parallelism between the slit and the grating rulings, the criticism being based on the fact that the plumb-line method of adjusting the slit is inferior to the spectroscopic. In the present paper are described experiments which prove conclusively that the plumb-line method is quite satisfactory and that the shifts noted in the first paper were not due to incorrect orientation of the slit. [See also Abstract No. 412 (1907).] E. C. C. B.

51. *Displacement of Spectral Lines by Pressure.* **O. W. Richardson.** (Phil. Mag. 14. pp. 557–578, Nov., 1907.)—This is a mathematical paper based on the electron theory. Its object is to try and establish the view that the displacement of the lines observed in the arc spectra at high pressures is an effect of the reaction on the emitting atom of forced vibrations set up in the neighbouring atoms. The forces causing the vibrations are the electrostatic forces called into play by the displacement of the electrons. A calculation of the effect to be expected on this theory is given, and the displacement is found to be in the direction of greater wave-length and to be proportional to the pressure of the gas. Both these results are in agreement with experiment. But the magnitude of the effect here calculated is of the order five to twenty-five times that observed experimentally. This is probably due to the complexity of atomic structure, as the theory is exact only for an atom in which the emitting system can be represented by the linear vibration of an electron. Effects due to the motion of the atoms are shown to be of little importance in calculating the displacement of the lines. The explanation of the discrepancy between the theoretical and observed effects is probably to be sought in the shielding effect of the other electrons in the atom. The possibility of perturbations of magnetic origin giving rise to displacements is considered at some length. The magnetic effects are, however, always found to be small compared with those of electrostatic origin. E. H. B.

52. *Absolute Measurement of the Zeeman-effect.* **A. Stettenheimer.** (Ann. d. Physik, 24. 2. pp. 384–396, Nov. 12, 1907. Inaug.-Dissertation, Tübingen, 1907.)—A very careful measurement of the value of $\Delta\lambda/\lambda^2H$ made upon two lines of the spectrum of zinc. Very special precautions were taken in the standardisation of the magnetic field. The value obtained, which has a maximum error of 0·1 per cent., is 19·01. E. C. C. B.

53. *The Influence of Pressure upon the Absorption Spectra of Gases.* **A. Dufour.** (Comptes Rendus, 145. pp. 757–758, Nov. 4, 1907.)—An extension of previous work to bromine vapour [see Abstract No. 1507 (1907)]. The

excess of pressure was produced by CO_2, H_2, or air, and it was found that the general absorption was much the greatest when CO_2 was used. Certain of the absorption lines do not shift when the pressure is increased, *e.g.*, $\lambda = 5584{\cdot}2$ t.m. On the other hand, about 50 of the lines do shift *e.g.*, $\lambda = 5585{\cdot}4$ t.m., for which the shift is about 0·028 t.m. for each atmo. of excess pressure. No evidence of the Zeeman-effect was noticed with a field up to 15,500 gauss. There appears to be no difference in the amount of shift observed when either of the three inert gases given above are employed.
E. C. C. B.

54. *The Influence of a Strong Magnetic Field on the Spark Spectra of Lead, Tin, Antimony, Bismuth, and Gold.* **J. E. Purvis.** (Cambridge Phil. Soc., Proc. 14. pp. 217–227, Oct. 15, 1907.)—A continuation of the author's work upon the Zeeman-effect [see Abstracts Nos. 1897 (1906), 58 and 882 (1907)]. He finds in the case of each of the above metals that the same type of resolution recurs in the spectrum, and, moreover, that there are types which are common to the spectra of several of the above elements. It is interesting to note, further, that there are lines in the spectra of Au, Sb, and Pb which conform to the type of certain series lines of Ag and Cu. The importance of this lies in the fact that it connects the metals which apparently exhibit no harmonic relations among their lines with the metals of the first and second groups of the periodic table. E. C. C. B.

55. *Optimum of Phosphorescence.* **J. de Kowalski** and **C. Garnier.** (Comptes Rendus, 145. pp. 391–393, Aug. 12, 1907.)—Bruninghaus [Abstract No. 1512 (1907)] has indicated a difference between his results concerning the photoluminescence of calcium sulphide containing samarium and those previously obtained by the authors [Abstract No. 1006 (1907)]. This difference is only apparent, for Bruninghaus investigated kathode luminescence during excitation, whilst the authors observed the permanent phosphorescence under the action of light after excitation by ultra-violet rays had ceased. The optimum varies with the nature of the excitation. With mixtures obtained by fusing 1 gm. of calcium sulphide with 0·08 gm. of sodium sulphate and small amounts of samarium nitrate, the maximum phosphorescence after excitation ceases is obtained with (1) 1 atom of Sa per 8,000 atoms of Ca, when excitation is produced by the ultra-violet rays of the quartz-mercury lamp and (2) with 1 atom of Sa per 125–400 atoms of Ca when kathode rays act as excitant. Similar but less sharp differences in the optimum of phosphorescence are observable with calcium sulphide containing Mn. In general, sulphides with a high content of luminophorous metal exhibit less permanent phosphorescence than the others. Also the relative intensity of the bands and lines of the photoluminescent spectra seems to depend on the concentration. T. H. P.

56. *Absorption by Luminescing Gases.* **A. Pflüger.** (Ann. d. Physik, 24. 3. pp. 515–526, Nov. 26, 1907. Physikal. Inst. d. Univ., Bonn, Sept., 1907.)—Some experiments to test the applicability of Kirchhoff's law to glowing gases—that is to say, to test whether ionised gases possess any power of absorbing those rays which they emit. The experiments were carried out, first at low pressures (1 mm.) and then at pressures of several cm. In the case of low pressures, two perfectly similar vacuum tubes in direct connection with one another were filled with the gas under examination to the

required pressure. Both tubes were mounted in direct line with another, so that the light from one passed through the other. The amount of light was measured by a Lummer-Brodhun spectrophotometer by comparison with some standard. The vacuum tube nearer the photometer was mounted in such a way that it could be lowered so that the light from the further one could, if desired, be passed direct into the spectrophotometer. Very careful measurements with air and hydrogen (both vacuum tubes being 1 m. long) showed no evidence of absorption of the rays they were emitting. In the experiments at higher pressures one vacuum tube only was employed, but this tube had a long, wide capillary portion and a short, narrow capillary, these two being in alignment but separated by a bulb, in which was sealed an electrode. There were two more electrodes, one at each end of the tube; three in all. By this means either capillary could be illuminated, or both together. In this apparatus, filled to a pressure of several cm., very definite absorption by hydrogen of H_α and H_β was obtained, and also self-reversal of H_α was seen. No absorption takes place by the hydrogen unless it is luminescing, showing that it is the ionised gas which acts. Similar results are described with Hg vapour in the arc lamp. E. C. C. B.

57. *Abrupt Limit of Distance in the Power of the Positive Rays to produce Phosphorescence.* **J. Kunz.** (Phil. Mag. 14. pp. 614–617, Nov., 1907.)—Experiment has shown that the *α*-rays from polonium and radium are able to penetrate a certain distance in air without losing their ionising power, while, after passing this distance, they suddenly lose this power almost entirely, at the same time losing their power of producing phosphorescence and of affecting a photographic plate. The author has carried out experiments to determine whether the positive rays exhibit similarly an abrupt cessation of the power to produce phosphorescence. A small Röntgen tube was arranged to be movable by means of an electromagnet inside an exterior tube 70 cm. long and 3·3 cm. in diam. The electrodes of the inner and outer tubes were connected; the kathode of the inner tube contained a tube with a hole 1·5 mm. in diam. so as to project canal rays into the outer tube; the kathode was earthed. The pressure in the two tubes is the same. At the end of the exterior tube there was a phosphorescent screen of willemite. On moving the interior tube towards the screen it was found that at a certain point the phosphorescence due to the positive rays suddenly appeared and increased with decreasing distance between the Röntgen tube and the screen. On again moving back the Röntgen tube the luminosity on the screen suddenly disappeared at the original point of disappearance. The points of appearance and disappearance in numerous successive experiments lay within a range of about 4 mm. The distance between the kathode and the screen was then about 41 cm. in air under a suitable pressure. The abrupt appearing and disappearing of the phosphorescent light did not depend on physiological causes. J. J. Thomson explains the existence of an abrupt limit of the ionising power of the *α*-particles of the radio-active elements by supposing that when the energy of the *α*-particle falls below a certain value a negatively electrified corpuscle gets attached to the corpuscle so that its positive charge is neutralised, and it becomes an uncharged atom with properties quite different from those of the original *α*-particle. In order that an *α*-particle and a corpuscle should separate after a collision between the two, the relative velocity of the particle and the corpuscle before impact must exceed a definite value v. From theory the limiting value $v = 1{\cdot}9 \times 10^8$ cm./sec. In recent researches on the positive

rays, J. J. Thomson has found the velocity of the positive particles to be 1·8 × 10^8 cm./sec. measured at some distance from the kathode. The velocity of the particles when they cease to produce phosphorescence must be somewhat smaller than this value on account of the passage of the particles through the gas. The agreement between theory and experiment is good.
J. J. S.

58. *Nature of Röntgen Rays.* **C. G. Barkla.** (Nature, 76. pp. 661–662, Oct. 31, 1907.)—Criticism of Bragg's hypothesis concerning the nature of Röntgen rays [Abstract No. 1826 (1907)]. To explain the phenomena of secondary radiation from light atoms, Bragg supposes that a neutral pair striking such an atom is returned unchanged. He also supposes that it is liable to be taken up only by an atom revolving in the same plane as itself, and that if ejected again the subsequent rotation and translation will continue to take place in the one plane. The secondary radiation in a direction perpendicular to that of propagation of the primary will hence consist of pairs rotating in the plane of the primary and secondary propagations, and the tertiary will therefore be strongest when in the same plane, thus giving polarisation. According to the ether pulse hypothesis the intensity of secondary radiation is at a minimum in a direction perpendicular to that of propagation of the primary and a maximum in or opposite to that direction. The same result follows from the neutral pair hypothesis, but whereas in the ether pulse theory the maximum intensity of secondary radiation is double of the minimum, on the latter theory it varies as the cosecant of the angle which the direction of propagation of the secondary makes with that of the primary. Taking into account the finite section of a beam and consequent obliquity of the rays, it is calculated that the intensities of the secondary rays in two given directions is 1·9 : 1 for the ether pulse and 8 : 1 for the neutral pair theory. Experiment shows the ratio is 1·6 : 1, and therefore conclusively supports the older theory. R. S. W.

59. *Selective Absorption of Röntgen Rays.* **G. W. C. Kaye.** (Cambridge Phil. Soc., Proc. 14. pp. 236–245, Oct. 15, 1907.)—McClelland and Thomson have shown that there is a close connection between the secondary radiation given out by a substance exposed to β-, γ-, or Röntgen rays and its atomic weight. The experiments here described have as object to derive a relation between primary Röntgen radiation and the atomic weight of the substance producing the rays. Antikathodes of various metals are mounted on a car so that, by an external electromagnet, they may in turn be brought before the kathode. The Röntgen rays produced pass through a thin Al window and then into an ionisation chamber, also closed with Al. The ionisation produced in this vessel is taken as proportional to the Röntgen rays produced. Without any absorbing screen between tube and testing vessel no relation between quantity of radiation and atomic weight is found, but when a sheet of Al is interposed the transmitted radiation is approximately proportional to the atomic weight of the metal used as antikathode over a wide range of atomic weights. An important result of the investigation shows that when the absorbing screen is made of the same metal as the antikathode the transmitted radiation is largely increased relatively to that coming from other metal antikathodes. This abnormal transparency is shared in less degree by metals with atomic weights differing little from that of the antikathode. This property indicates that the atomic weight of nickel is nearer to copper than to iron, judging from the figures obtained. R. S. W.

60. *Secondary Röntgen Radiation.* **R. T. Beatty.** (Phil. Mag. 14. pp. 604–614, Nov., 1907.)—Air is one of those substances which cause scattering of Röntgen radiation, and in air the absorption is very small. Investigations were made to find whether the incident radiation was perfectly scattered under all conditions. It was observed that the secondary rays are initially more penetrating than the primary, but as the softer rays are cut off from the main beam the penetrative power falls below unity. This can be explained by assuming (1) that in the secondary beam the softer rays are less strongly represented than they would be if perfect scattering took place; (2) that the hard rays are somewhat transformed into a softer radiation, so that when the hard rays alone are operating the secondary rays appear more absorbable than the primary. It was found that there is a marked increase in the penetrative power for thick plates, but when the harder rays only were operating there was a decided drop in the penetrative power shown by a plate of Al 0·265 cm. thick. This indicates a transformation by air into a softer radiation of those rays which were able to get through the 0·265-cm. plate. The experimental evidence points to the conclusion that the softer rays are only feebly scattered, and that the harder rays are transformed into a softer radiation. J. J. S.

61. *Secondary Röntgen Radiation from Gases and Vapours.* **J. A. Crowther.** (Phil. Mag. 14. pp. 653–675, Nov., 1907.)—Barkla's experiments [Abstracts Nos. 1023 and 1650 (1904)] included only a few gases. None of these possessed great density, nor did they include very complex molecules nor elements of high atomic weight. The present paper extends the inquiry to these points. It is first proved that the secondary radiation from a given volume of air is proportional to the pressure, and use is then made of this fact to render the final method a null one. Röntgen rays pass from a bulb symmetrically into two chambers A, A′; the secondary rays produced by the contained gases pass at right angles through a thin Al window into two testing vessels B, B′. The outer cases of these are connected to the opposite poles of a battery, and the inner insulated parts to the same gold-leaf electroscope. When A and A′ are filled with air at the same pressure and the rays from the bulb allowed to pass, the electroscope shows no leak. If another gas be put in A′ the air pressure in A may be adjusted to reduce again the leak to zero. Errors arising from spontaneous ionisation and the tertiary radiation from the Al windows are eliminated by the method of taking observations. A further correction is applied for the unequal absorptions of the secondary rays from different substances. The chief results are the following: Seventeen gases and vapours have been tested. The absorbability of the secondary radiation varies with the gas; in general the nature of the radiation is the same whether the element is in the solid or gaseous state. The secondary rays from a molecule of gas are the sum of those from the atoms composing the molecule. Gases may be divided into two classes, according as they merely scatter or transform the primary radiation. For the former class, which contains the elements with an atomic weight less than that of sulphur, the secondary radiation per atom is proportional to the atomic weight, with the exception of hydrogen. Elements of higher atomic weight give off secondary radiation in very much larger amounts, and generally of a much softer character. The ratio of the intensities of the primary and secondary beams is independent of the intensity of the primary rays and, generally, of their hardness. For some gases, however, the intensity of the secondary beam increases as the hardness of the primary rays is increased. R. S. W.

62. *Secondary Kathode Rays emitted by Substances exposed to γ-Rays.* **R. D. Kleeman.** (Phil. Mag. 14. pp. 618–644, Nov., 1907.)—An account is given of experiments on the amount of secondary kathode radiation from different substances, as measured by the ionisation these secondary rays produce in air. It appears that the increase of secondary radiation with atomic weight is, on the average, greater the higher the atomic weight. It was found that the γ-rays from radium are heterogeneous, and that the different constituent rays give rise to different relative values for the secondary radiation of a set of substances. The constituent rays are selectively absorbed, and a partial separation of different sets of rays from the original bundle can be effected by means of metal screens. The experiments carried out show that the rays from radium consist principally of two groups of rays, the constituent rays of each group not differing much from one another in their properties. The rays of one of the groups are more efficient in producing secondary kathode radiation from Al, Sulphur, Fe, Ni, Zn, and Sn than from Pb, and all are more or less easily absorbed by each of these substances excepting Pb, the absorption by Pb being much less. The rays of the other group are more efficient in producing secondary kathode radiation from lead than from the other substances, and are more easily absorbed by Pb, Hg, and Bi than by any of the other substances. There is also a third and weak group of rays, which is most efficient in producing secondary radiation from carbon. This group of rays is less easily absorbed by the substances mentioned than either of the other groups. Thus, when it is required to shield a piece of apparatus from the γ-rays of radium it is better to use a combined screen of lead and one of the metals Fe, Zn, or Cu than a screen composed of one of these metals only. The γ-rays of radium resemble Röntgen rays in the absorption by a substance depending on the nature of the rays and that of the absorbing substance. Moreover, the amount of secondary radiation from a substance exposed to γ-rays depends on the nature of the rays, as is the case with Röntgen rays. These facts are additional evidence that the general nature of γ- and Röntgen rays is the same. Both Röntgen and γ-rays probably consist of electromagnetic pulses, produced by the acceleration of electric charges. Since the β-ray activity due to RaF is small in comparison with that due to RaC, in the case of radium only a few years old, the γ-rays from radium are principally produced by the acceleration of the electrons ejected by RaC.

J. J. S.

63. *Luminosity of Radium Emanation and Radio-activity of Uranyl Molybdate.* **E. Wedekind.** (Chem. Zeit. 31. pp. 1108–1109, 1907.)—The gas evolved on treating 1 gm. of barium-radium carbonate with HCl is passed into a glass tube, closed at one end, and then acted on by KOH. The upper part of the tube is found to glow when examined in the dark, although only a very small quantity of gas remains. The negative results obtained by Szilárd with uranyl molybdate [Abstract No. 1841 (1907)] are borne out by the author's experiments with this substance. L. H. W.

64. *Origin of Radium.* **E. Rutherford.** (Nature, 76. p. 661, Oct. 31, 1907.)—In a previous paper it was shown that a substance could be separated from actinium which was slowly transformed into radium [Abstract No. 1354 (1907)]. Observations on the actinium solutions, extending over 240 days, have not shown the slightest growth in radium. In reply to Boltwood [see Abstract No. 1882 (1907)] the author states that he did not use old ammonium sulphide, but passed H_2S into the actinium solution already saturated with ammonia. It is suggested that at some future time when there is less possibility of new substances being discovered the whole system of nomenclature should be revised. R. S. W.

65. *Origin of Radium.* **O. Hahn.** (Ber. Deut. Chem. Gesell. 40. pp. 4415–4420, 1907. Chem. News, 96. pp. 272–273, Dec. 6, 1907. Abstract. Nature, 77. pp. 80–81, Nov. 14, 1907.)—An account of experiments supporting Boltwood's conclusions concerning the parent substance of radium, and showing that it possesses chemical properties closely allied to thorium [Abstract No. 1882 (1907)]. It has been noticed that old preparations of pure thorium contain relatively large amounts of radium; and this is the more noteworthy since the monazite sand from which the thorium is prepared contains but little uranium. A systematic study of the quantity of radium in samples of thorium salts of different ages has been undertaken. An aqueous solution of pure nitrate is made, boiled, and sealed up. After a sufficient interval the radium emanation is collected by boiling the solution, and after allowing time for the thorium emanation to decay, is transferred to an electroscope and measured. It is found that the older the sample the larger the quantity of radium contained in it. This cannot be ascribed to insufficient purity, nor is it probable that thorium itself decomposes into radium. It is therefore probable that in the technical preparation of thorium an active substance is separated with the latter, and that this is the direct parent of radium. Various tests are given showing the growth of radium in thorium solutions. A solution of radio-thorium is prepared from thorianite by means of barium sulphate; this does not contain the parent substance. Knowing the proportion of uranium and thorium in monazite sand, and assuming that all the thorium and parent substance are separated therefrom during the extraction of thorium, the life of radium can be calculated by determining the quantity of radium in a given weight of thorium of known age. The period of decay lies between 2,000 and 3,000 years. Fuller details are to be published. R. S. W.

66. *Radio-activity of Lead.* **H. Geitel.** (Phys. Zeitschr. 8. p. 776, Oct. 24, 1907. Paper read before the 79 Naturforscherversammi., Dresden.)—The author states that he has verified the conclusion previously arrived at by himself and J. Elster, that the radio-activity of lead is due to RaF (polonium) [see Abstract No. 1158 (1907)], by using a piece of lead which is over 100 years old. The chemical separation is carried out in a laboratory where contamination with polonium is unlikely to occur. An account of the experiment is to be published later. S. G. S.

67. *Action of Kathode Rays on Uranium Salts.* **W. P. Jorissen** and **W. E. Ringer.** (Chem. Weekblad, 4. pp. 242–246, 1907.)—Exposure of 1/10 gm. of uranoso-uranic oxide to kathode rays for one hour reduced the weight, on cooling, to 71 mgm. It was found that the activity of the resulting substance in discharging an electroscope is 30 per cent. greater than that of a similar preparation not exposed in this way. [Compare Abstract No. 1840 (1907).] L. H. W

68. *Charging Effect with Polonium Preparation.* **E. Aschkinass.** (Phys. Zeitschr. 8. pp. 773–774; Discussion, pp. 774–775, Oct. 24, 1907. Paper read before the 79 Naturforscherversammi., Dresden.)—A polonium deposit upon

a copper plate of 4 cm. diam. is insulated and surrounded by a copper vessel which is earthed and which can be exhausted. The disc is connected to an electrometer, and with a magnetic field parallel to the surface of the preparation the disc acquires a negative potential (about —1 volt). The author considers this to be due to the emitted electrons which, on account of the field, return to the disc. With no field the plate acquires an equal positive potential. Assuming, then, that an α-particle has a positive charge equal in amount to the negative charge of an electron, the number of electrons emitted by the preparation in a given time is twice as great as the number of α-particles; but if the charge on the α-particles is twice that amount, the number of electrons emitted is four times that of the α-particles, the latter escaping from the plate entirely in both cases, since the curvature of their path in the magnetic field is so small. S. G. S.

69. *Passage of the β-Rays of Actinium through Matter.* **H. W. Schmidt.** (Phys. Zeitschr. 8. pp. 737–748, Oct. 24, 1907. Paper read before the 79 Naturforscherversamml., Dresden.)—A *résumé* of the work with the β-rays of UrX which has been previously published [see Abstract No. 1881 (1907)], followed by an account of similar experiments with a preparation of actinium. Similar results are obtained, but whereas the value of the quantity $100\beta/AD$ is 12·4 for the UrX experiment with extreme values 18·6 and 11·2, it varies from 22·2 for Mg to 18·0 for Pt and Pb. Also the quantity $(\alpha/D)A^3$, which varies irregularly between 12·0 and 9·8 for UrX (mean = 11·2), varies from 25·7 (Sn) to 22·8 (Al) with a mean value of 24·0. It is suggested that the variations in the first constant may be due to error of determination, the aluminium plate upon which the preparation is deposited producing different errors in different cases; thus the values of the two universal constants depend upon the particular kind of rays to which they refer. S. G. S.

70. *Gases in Minerals from Greenland.* **J. Thomsen.** (Acad. Sci. Kopenhagen, Bull. pp. 53–57, 1904. Zeitschr. Kryst. u. Min. 43. p. 89, 1907.) —The only mineral which was found by the author (in 1898) to contain helium (24 c.cm. from 1,000 gm.) was a reddish-brown fluorite from the cryolite deposit at Ivigtut. English green fluorite gave no helium. L. H. W.

71. *Radium in Rocks.* **A. S. Eve** and **D. McIntosh.** (Phil. Mag. 14. pp. 231–237, Aug., 1907. Paper communicated to the Royal Society of Canada.)—Near the earth's surface there is about 28 times as much radium present as will account for the existing temperature-gradient within the earth. Strutt's estimate, which gives rise to this conclusion, was based upon samples of rocks from the Old World only. The authors examined rocks from the neighbourhood of Montreal, belonging to Devonian, Ordovician, and Post-Tertiary formations. The quaternary sand contained $0{\cdot}16 \times 10^{-12}$ gm. of radium per gm., the clays 0·78 and 0·80, the Devonian rocks 1 to 4 billionths, and the Ordovician limestones 0·92. The mean of all values is $1{\cdot}1 \times 10^{-12}$, which agrees well with Strutt's $1{\cdot}4 \times 10^{-12}$. The authors also studied various methods of getting rid of the emanation. E. E. F.

72. *Radio-activity of Vesuvian Cotunnite.* **P. Rossi.** (Accad. Lincei, Atti, 16. pp. 630–633, Nov. 3, 1907.)—From a full investigation of the properties of this mineral the author concludes that it contains no radium, its activity

being due to RaD, RaE, and RaF. The great similarity in chemical properties between RaD and Pb possibly explains the radio-activity of Pb-minerals of volcanic origin. [See also Abstract No. 1358 (1907).]
W. H. Si.

73. *Radio-activity of Subterranean Waters.* **F. Dienert** and **E. Bouquet.** (Comptes Rendus, 145. pp. 894–896, Nov. 18, 1907.)—In a preceding paper [Abstract No. 907 (1906)] the authors have shown that the sources of the Ville de Paris are slightly radio-active, and this radio-activity is not constant, but varies according to the time of the year. The geological formations in which mineral waters have their origin are usually too complex to render it easy to account for the variation of the radio-activity of such waters. On the contrary, the formation round the sources of the Avre is well known. For a year the authors have studied the radio-activity of the source of the Rueil (one of the sources of the Avre), observations being taken almost every day. Curves are given showing (i.) the variation of the radio-activity, (ii.) the variation of electrical resistance, and (iii.) the alteration of the water-level of the Bois-Normand well, situated at the edge of the collecting ground of the river. These three curves are, within the limits of possible errors, parallel to one another. The increase of electrical resistance and of the water-level in the well correspond to an inflow of surface water, which is not radio-active; and consequently, when this water mixes with the radio-active water already present, it would be expected that the radio-activity would be lowered. The reverse effect, however, is observed, and from this the authors conclude that the surface water rapidly dissolves the emanation it meets in its passage through the soil. It seems reasonable to suppose, then, that the surface layers of the ground in this region (Turonian chalk) are more radio-active than the layers lower down. If this be true, less radio-activity should be found in the deeper waters of this region. This was confirmed by experiment. A boring 80 m. deep at the edge of the source of the river gave water coming from the Turonian chalk, but having a mean resistivity of 8,250 ohms and a radio-activity three or four times weaker than the minimum observed at the source of the river. The authors will investigate next the variations of radio-activity of the sources of the Breuil, which rises in the same region, but has a radio-activity greater than the Rueil. A. W.

REFERENCES.

74. *Measurement of the Optic Axial Angle of Minerals in the Thin Section.* **F. E. Wright.** (Amer. Journ. Sci. 24. pp. 317–369, Oct., 1907.)

75. *Passage of Light through a Heterogeneous Film.* **P. Boedke.** (Ann. d. Physik, 24. 2. pp. 357–366, Nov. 12, 1907.)—The treatment is mathematical and based on the electromagnetic theory. The film is supposed to have parallel plane faces and to consist of a number of very thin parallel layers, each one of which is homogeneous, though different from its neighbours. E. H. B.

76. *Significance of Resonance in the Theory of Spectral Lines.* **V. W. Ekman.** (Ann. d. Physik, 24. 3. pp. 579–596, Nov. 26, 1907.)—The breadth of the spectral lines may be due to the Doppler-effect [see Abstract No. 1861 (1906)] or to a lack of simple harmonic vibrations in the radiating centres. A departure from the simple sine vibrations in the case of a denser gas may be ascribed (on the electron theory) to the induction effects between the vibrating electron and those near it. This is the view here developed. E. H. B.

HEAT.

77. *New form of Bomb Calorimeter.* **H. N. Potter.** (Amer. Electrochem. Soc., Trans. 11. pp. 259–268; Discussion, p. 268, 1907.)—A description of a modified form of the Berthelot-Atwater bomb calorimeter, suitable for the combustion of substances which produce solid oxides. On burning such substances in oxygen under pressure in the ordinary form of bomb calorimeter, the oxide produced forms a protective coat around the larger portion of the test sample, and this inner core therefore remains unburned. The amount of substance burned can be ascertained by weighing the bomb and its contents before and after the combustion; the increase in weight gives the oxygen present in combined form as oxide. The ordinary Atwater form of bomb is, however, unsuited for this method of work, and the author has modified it by providing a thin light inner lining of some chemically inert material which fits closely into the outer steel bomb. The lining of the cover of this modified bomb is also made removable, and to this inner removable cover the electrical contacts and crucible holder are attached. The inner cover joins with the old lining of the bomb, to form a completely closed removable bomb, of such small weight that it can be accurately weighed, upon a special balance having a load capacity of 500 gm., with an error of only $\frac{1}{10}$ mgm. The removable bomb lining and its cover, which weigh together 220 gm., are charged with the sample, and then weighed before and after the combustion. The gain in weight represents the combined oxygen, and from this the weight of substance burned can be calculated. The average of five combustions of silicon carried out in this bomb by the method described gave an average value of 7,594·8 cals. per gm. The material used tested 99·6 per cent. Si, and was ground with flint pebbles in a ball mill. **Richards,** in the *discussion,* pointed out that the calorimetric value of silicon had been unsettled for many years—the two previous determinations having given widely divergent results—namely, 6,480 and 7,680 cals. The author had, therefore, performed a most important work. J. B. C. K.

78. *Potentiometer Installation for Pyrometry.* **W. P. White.** (Phys. Rev. 25. pp. 334–352, Nov., 1907.)—For the most accurate pyrometry, with temperatures up to 1,600° C., a thermo-element with a potentiometer is the most satisfactory measuring apparatus. Rapidity is secured (*a*) by proper selection and arrangement of the galvanometer; (*b*) by the use of switches to exchange thermo-elements, adjust zero, &c.; and (*c*) by relying upon the galvanometer for as much of the reading as possible so as to minimise potentiometer manipulation. External leakage can be prevented and internal leakage greatly diminished by equipotential shields, which interpose a continuous metallic surface between the circuit and the source of disturbance. Internal leakage also decreases with the resistance of the potentiometer. A slide-wire potentiometer is very undesirable in rapid work, and especially in melting-point and calorimetric determinations. F. E. S.

79. *Expansibility of Platinum at very Low Temperatures.* **K. Scheel** and **W. Heuse.** (Phys. Zeitschr. 8. pp. 756–760, Oct. 24, 1907. Paper read before the 79 Naturforscherversamml., Dresden. Communication from the

Physikal.-Techn., Reichsanstalt.)—The results of the observations of Kamerlingh Onnes and Clay [see Abstract No. 278 (1907)] by means of a cathetometer used as a comparator not being quite in accordance with those of Scheel by Fizeau's method [Abstract No. 481 (1907)], the authors have examined the expansibility of platinum at low temperatures by means of a comparator, with avoidance of the special sources of error in the arrangement used by Kamerlingh Onnes and Clay, and find for the expansion between -183° and 16° C.—

$$l/l_0 = 1 + 8{\cdot}911 \times 10^{-6} t + 4{\cdot}91 \times 10^{-9} t^2.$$

New measures were made by the Fizeau method on a portion cut off from the Pt bar used with the comparator; but only the result is given that they indicate an expansion of 1,608 μ per metre in the whole range considered. For this the observations with the comparator give 1,610 μ, those by Scheel 1,594 μ, and those by Kamerlingh Onnes and Clay 1,637 μ. R. E. B.

80. *Warming of a Silver Iodide Rod by Stretching.* **R. Wagner.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2a. pp. 925–930, May, 1907.)—Since AgI contracts when warmed it should, by Kelvin's rule, be warmed by sudden stretching. This was found to be the case, rods of 4 mm. diam. being used, and weights of less than 2½ kg. The temperature-changes were measured by iron-constantan thermo-junctions fused into the rods, and were on the average found to be 0·00008° per kg. Kelvin's formula, with the usual data for AgI, gives 0·00015° per kg., so that the rule is only indicated qualitatively by these observations. R. E. B.

81. *Calorimetric Resistance Thermometers.* **H. C. Dickinson** and **E. F. Mueller.** (Bureau of Standards, Bull. 3. pp. 641–661, Oct., 1907.)—An investigation dealing with the adaptation of the resistance thermometer to calorimetric and other uses for which the ordinary form is not suited. The first part of the paper contains a description of the instrument and its calibration, the second part deals with the determination of the transition-point of sodium sulphate by means of two of the thermometers. The value found by Richard and Wells was 32·383° C.; the redetermination by the authors gave 32·384°. G. E. A.

82. *The American Standard Scale of Temperature.* **C. W. Waidner** and **H. C. Dickinson.** (Bureau of Standards, Bull. 3. pp. 663–728, Oct., 1907.)—A report of the comparison of a number of mercurial standard thermometers. The investigation shows that the standard scale of temperature of the Bureau of Standards in the interval 0° to 100° C., as defined by these thermometers, and the supercorrections resulting from the investigation, is in agreement with the hydrogen scale of temperature of the Bureau International to within the limits of accuracy at present attainable in mercurial thermometry (about 0·002°). G. E. A.

83. *Rotation of Gas Molecules.* **R. Girtler.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2a. pp. 759–770, April, 1907.)—Assuming molecules to be absolutely smooth elastic bodies, the author calculates that they have a virial due to rotation equal to 0, pv, or $\frac{3}{2}pv$, according as they are spheres, or have other surfaces of revolution, or are irregular in shape. Their virial of progression

being $\tfrac{3}{2}pv$, Kirchhoff's formula, $\kappa = 1 + \tfrac{2}{3}/(1 + U_r/U_p)$, for the ratio of the isopiestic and isometric specific heats, where U_p and U_r are the kinetic energies of the progressive and rotatory motions, gives 5/3, 7/5, 4/3 as the value of this ratio for molecules of the above shapes. R. E. B.

84. *Vibrating Systems not subject to the Boltzmann-Maxwell Law.* **W. Peddie.** (Roy. Soc. Edinburgh, Proc. 27. pp. 181–194, 1906–1907.)—The conclusions obtained before [see Abstract No. 1409 (1906)] are here confirmed, and it appears that the doctrine of equipartition of energy cannot be either proved or disproved for a vibratory system having *m* degrees of freedom with *m* distinct periods, but that if even only two of the periods are the same an infinite number of cases are possible wherein equipartition is not observed. The author then, by general reasoning, defends Kelvin's conclusion [Abstract No. 2072 (1901)] on the non-equipartition of energy in non-vibratory systems against a criticism by Magie [Abstract No. 742 (1906)].
R. E. B.

85. *Partition of Heat Energy in the Molecules of Gases.* **P. Ehrenfest.** (Roy. Soc. Edinburgh, Proc. 27. pp. 195–202, 1906–1907.)—A class of cases in which elastically oscillating systems exhibit non-equipartition of energy is found with special simultaneous assumptions regarding (*a*) the mechanical structure of the oscillating molecules, (*b*) the character of the collisions among the molecules; but this class is excluded from Boltzmann's line of thought. Further, the existence of the special class deduced by Peddie [see Abstract No. 1409 (1906)], which would be irreconcilable with Boltzmann's law, is not provable. [See also preceding Abstract.] R. E. B.

REFERENCES.

86. *Influence of the Glass Cover on Actinometric Thermometers.* **L. Gorczynski.** (Meteorolog. Zeitschr. pp. 212–218, May, 1907. Monthly Weather Rev. 35. pp. 358–361, Aug., 1907. Translation.)—Calculations are made from which it appears that in mercurial thermometers in which the glass reservoir is not directly exposed to the sun's rays, but is covered by an absorbing layer of lampblack, the assumption of the identity of the actual temperature fluctuation with that of the mercurial column alone is not admissible without further investigation. G. E. A.

87. *Isometric Specific Heat of Solids.* **G. N. Lewis.** (Amer. Chem. Soc., Journ. 29. pp. 1165–1168, Aug., 1907. Zeitschr. Anorg. Chem. 55. 2. pp. 200–204, Aug. 27, 1907. Translation.)—It is concluded that the isometric atomic heat is more nearly constant for the solid elements whose atomic weights are greater than that of potassium than is the isopiestic atomic heat. There is nothing new either in the calculation or in the conclusion. R. E. B.

88. *Physically Similar Fluids.* **Jouguet.** (Comptes Rendus, 145. pp. 475–477, Sept. 2, 1907.)—Two fluids, which are geometrically similar and have the initial densities and temperatures at homologous points in given ratios, are defined to be physically similar if the subsequent motions are similar whatever be these ratios or the relative dimensions. Perfect gases are then shown to be physically similar fluids, and certain conclusions are drawn with respect to detonation in air. [See Abstract No. 52 (1906).] R. E. B.

SOUND.

89. *Multiple Tones from a Fork.* **G. Sizes and G. Massol.** (Comptes Rendus, 145. pp. 872–874, Nov. 18, 1907.)—By an attachment with soft wax at a vibrating segment a trace is obtained upon a smoked paper on a rotating drum. The trace is afterwards examined by a microscope on a dividing machine. From a fork of pitch $ut_0 = 32$ complete vibrations per sec. the authors found the very large number of overtones and *undertones* (*harmoniques graves*) shown in the following table :—

Undertones.			Overtones.					
Frequencies.	Notes.	Relative Frequencies.	Frequencies.	Notes.	Relative Frequencies.	Frequencies.	Notes.	Relative Frequencies.
2	ut_{-4}	1/16	$42\frac{2}{3}$	fa_0	4/3	$266\frac{2}{3}$	$ut^{\sharp}_3$	25/3
4	ut_{-3}	1/8	48	sol_0	3/2	280	e'_3	35/4
$4\frac{2}{3}$	$mi^{\flat}_{-3}$	7/48	64	ut_1	2/1	400	$sol^{\sharp}_3$	25/2
$5\frac{1}{3}$	fa_{-3}	1/6	96	sol_1	3/1	533	$ut^{\sharp}_4$	50/3
7	$si^{\flat}_{-3}$	7/32	100	$sol^{\sharp}_1$	25/8	600	$re'^{\sharp}_4$	75/4
8	ut_{-2}	1/4	128	ut_2	4/1	800	$sol^{\sharp}_4$	25/1
$10\frac{2}{3}$	fa_{-2}	1/3	140	re'_2	35/8	960	si_4	30/1
16	ut_{-1}	1/2	200	$sol^{\sharp}_2$	25/4	1,024	ut_5	32/1
24	sol_{-1}	3/4	224	$si^{\flat}_2$	7/1	1,066	$ut^{\sharp}_5$	100/3
28	$si^{\flat}_{-1}$	7/8	240	si_2	15/2	1,120	re'_5	35/1
32	ut_0	1	256	ut_3	8/1	2,240	re_6	70/1

E. H. B.

90. *Theory of Closed Resonators.* **M. Thiesen.** (Ann. d. Physik, 24. 3. pp. 401–438, Nov. 26, 1907. Communication from the Physikal.-Techn. Reichsanstalt.)—This highly analytical paper deals with the sound vibrations possible in closed resonators. Its chief parts may be summarised as follows : (1) Kirchhoff's differential equations for sound in a viscous, heat-conducting gas are newly derived and under more general assumptions. (2) Under certain conditions at the surface, solutions of the equations are obtained for the sphere and cylinder. (3) To the first approximation the corrections to the frequencies for vicosity and heat conduction for the sphere are derived. Similar results are obtained for the cylinder in the case where a certain relation holds between radius and wave-length. (4) A simple relation, independent of the coefficients of vicosity and heat conduction, as also of the particular form of the resonator, is obtained between (*a*) the change of sound intensity of the resonator with pitch of the exciter, and (*b*) the displacement of the maximum of the intensity through vicosity and heat conduction. E. H. B.

91. *Relation of Sensitiveness of the Ear to Pitch.* **Rayleigh.** (Phil. Mag. 14. pp. 596–604, Nov., 1907.)—In 1894 (Phil. Mag. 38. p. 365 and Scientific Papers, iv. p. 125) the author found the sensitiveness of the ear to sounds of different pitches to be as follows :—

c' (256)	$s = 6{\cdot}0 \times 10^{-9}$
g' (384)	$s = 4{\cdot}6 \times 10^{-9}$
c'' (512)	$s = 4{\cdot}6 \times 10^{-9}$

where s is the condensation (or rarefaction). Here the condensation is the maximum which occurs during the course of a vibration, but the vibration (and s with it) is the minimum capable of impressing the ear in a progressive wave. The method employed depended upon a knowledge of the rate at which energy was emitted from a resonator under excitation by a freely vibrating tuning-fork. In a careful re-examination of this question, M. Wien, working with the telephone, finds not only a still higher degree of sensitiveness, but a much more rapid variation with pitch, as shown by the following figures :—

N.	γs.	N.	γs.
50	$1{\cdot}6 \times 10^{-7}$	1,600	$1{\cdot}4 \times 10^{-11}$
100	$1{\cdot}1 \times 10^{-8}$	3,200	$1{\cdot}4 \times 10^{-11}$
200	$1{\cdot}0 \times 10^{-9}$	6,400	$2{\cdot}3 \times 10^{-11}$
400	$1{\cdot}2 \times 10^{-10}$	12,800	$8{\cdot}0 \times 10^{-11}$
800	$2{\cdot}3 \times 10^{-11}$		

In this table, N shows the frequencies, γ the ratio of the specific heats (1·41), and s is the condensation. The present author, to further test the question, experimented in a new way using metal cans as vibrators maintained by electromagnets. The cans were cylindrical with one flat end and the other end open, and were made to vibrate like bells. The comparison between two such cans was made by use of the general principle of dynamical similarity. Thus, for two precisely similar forks of the same material the periods are as their linear dimensions. With the cans of dimensions as 2 : 1 and making 128 and 256 vibrations per sec., it was found that for equal audibility at distances as 2 : 1 the radial amplitude of the larger can required to be 4 times that of the smaller. Equal aerial condensations at the points of observation require amplitudes in the ratio of 2 : 1, from which it is inferred that for equal audibilities the condensation needed at pitch 128 is double of that needed at pitch 256. In like manner the condensation needed at 256 was 1·6 of that at 512 per sec. Finally, the condensation necessary for audibility at 85 per sec. was almost precisely double of that for pitch 128. Confirmation was also obtained by direct comparison between the cans of frequencies 85 and 256. Thus to summarise :—

N	512	256	128	85 per sec.
Relative values of *s*	1	1·6	3·2	6·4

Thus the differences of sensitiveness are less than those found by Wien, the author being at a loss to explain the discrepancy. E. H. B.

REFERENCES.

92. *Quincke's Interference Tube.* **F. Handke** and **F. F. Martens.** (Deutsch. Phys. Gesell., Verh. 9. 7. pp. 121–124, April 15, 1907. Phys. Inst. d. Handelshochschule, Berlin, March, 1907.)—Describes an improved form of Quincke tube. E. H. B.

93. *Marage's Talking Siren.* **A. Gradenwitz.** (Scientific American, 96. pp. 389–390, May 11, 1907.)—Describes the discs of the siren, and the artificial mouths used by Marage in his laboratory synthesis of the French vowels *a, é, i, o, ou.* The arrangement is used for testing deaf patients, their acuteness of hearing being tabulated for each of these vowels, which may be produced at will of various intensities and registered by the pressure of the air-blast used. E. H. B.

94. *Graphical Record of Acoustical Beats.* **C. Déguisne.** (Ann. d. Physik, 23. 2. pp. 308–316, June 13, 1907. From the Psycholog. Inst. d. Akad., Frankfurt.)—Gives a number of records (by smoke traces on a moving strip as introduced by K. Marbe) of acoustical beats. These are between two forks, or one fork and an alternating current. E. H. B.

95. *Combination Tones.* **E. Waetzmann.** (Ann. d. Physik, 24. 1. pp. 68–78, Oct. 8, 1907. Physikal. Inst., Breslau, Aug., 1907.)—Discusses the Helmholtz theory of combination tones, and in the main defends it against the various criticisms to which it has been subjected. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

96. *Number of Electrons in Metals and their Free Paths.* **L. Bloch.** (Comptes Rendus, 145. pp. 754–757, Nov. 4, 1907.)—Drude has given the formula $n^2a = \sigma_\infty T$, where $n =$ the refractive index corresponding to period T, $a =$ coefficient of absorption and $\sigma_\infty =$ the conductivity in electrostatic units. He found that experiment did not support the formula. The question raised is whether the formula would be satisfied if σ_∞ is replaced by σ_λ, the conductivity relative to the period T. Thomson has recently given an expression for σ_λ, viz., $\sigma_\lambda = (2N'e^2/m)[\sin^2(\phi t_2/2)/q^2]$, ($q = 2\pi/T$, $t_2 =$ time for the mean free path, $N' =$ number of mean free paths per unit volume per unit time) [see Abstract No. 1545 (1907)]. If N is the number of free electrons per cm.^{3}, $N't_2 = N$ and—

$$\sigma_\lambda = (Ne^2/m)[\sin^2(qt_2/2)/(qt_2/2)^2]t_2/2,$$

and therefore—

$$\sigma_\infty = (Ne^2/m)t_2/2,$$

and finally—

$$n^2a/\sigma_\infty T = \sin^2(qt_2/2)/(qt_2/2)^2.$$

The first member is known from Drude's measurements, and hence t_2 is found. The last equation but one then gives N, and the values for N so obtained are compared with those deduced from the electron theory. The results are given in the table.

	I. n^2a.	II. σ_∞.	III. $\sigma_\infty T$.	IV. t_2.	V. N.	VI. N_1.	VII. $\frac{N}{N_1}$
Ag	0·66	$60{\cdot}9 \times 10^{15}$	1080	$1{\cdot}960 \times 10^{-15}$	27×10^{23}	$0{\cdot}82 \times 10^{23}$	33
Cu	1·68	56	1008	1·922	26	1·2	21
Au	1·04	40	720	1·926	19	0·84	22
Al	7·46	32	576	1·792	17	0·81	21
Zn	11·67	17	306	1·660	9	0·92	5·6
Na	0·013	21	378	1·986	9	0·36	26
Na—K ...	0·26	17 (?)	379	1·928	8	0·26	31
Mg	1·61	20	360	1·872	9	0·60	15
Cd	5·62	13	234	1·726	6	0·65	9
Pt	8·78	9·24	166	1·606	5	0·93	5·4
Sn	7·81	8·5	153	1·608	5	0·51	10
Acier	8·19	5	90	1·504	3	1·00	3
Ni	6·09	8·1	145	1·646	5	1·3	3·8
Co	8·53	9	162	1·596	5	1·2	4·1
Sb	8·53	2·6	46·8	1·116	2	0·51	4
Hg	8·58	1·05	18·9	0·940	1	0·57	1·2
Bi	6·86	0·7	12·6	0·846	0·8	0·40	2

It is seen that t_2 is approximately constant for all metals. If the electrons obey the law of equipartition of energy, their mean velocity $= 7{\cdot}6 \times 10^6$, and combining this with t_2 the free paths range from $1{\cdot}5 \times 10^{-8}$ to $0{\cdot}7 \times 10^{-8}$. For

Hg and Bi these agree with Drude's numbers; for Au, Ag, and Cu they are notably larger. Larmor has recently shown that paths greater than 10^{-7} are unlikely. The numbers in column 5 also agree with Larmor's estimate of $\frac{1}{4} \times 10^3$. Column 6 contains the number of atoms of the metal per c.cm.; column 7 the ratio of the number of electrons to the number of atoms. These ratios are larger than those given by Drude. They do not agree with Thomson's hypothesis that the number of electrons per atom is of the order of the atomic weight. R. S. W.

97. *Electromagnetic Mass of the Electron.* **A. Righi.** (Phys. Zeitschr. 8. pp. 801–802, Nov. 1, 1907. From the Italian.)—A reply to Pockels [Abstract No. 1880 (1907)]. The assumption of an upper limit of the elasticity of the ether is only one of many ways in which the electron may be interpreted. The mass of an electron may be defined quite logically as that mass which a material particle would have to possess in order at a given velocity to possess a kinetic energy equal to the increase of energy of the electron when endowed with the same velocity. E. E. F.

98. *Electrical Conduction and Electron Theory of Solids.* **J. Koenigsberger.** (Phys. Zeitschr. 8. pp. 833–836; Discussion, p. 836, Nov. 15, 1907. Paper read before the 79 Naturforscherversamml., Dresden.)—The following formula is deduced to give the resistance of oxides, sulphides, &c., which conduct electricity without chemical change:—

$$w = w_0(1 + \alpha t \pm \beta t^2)e^{\overline{-q\frac{t}{(t+273)273}}}.$$

α, β are the same as for metals, and q is a positive constant. In the *discussion*, **Nernst** says that below 1,500° most of the conduction is electrolytic, but the **Author** points out that impurities may largely bring this about. R. S. W.

99. *A New Determination of the Ratio of the Electromagnetic to the Electrostatic Unit of Electricity.* **E. B. Rosa** and **N. E. Dorsey.** (Bureau of Standards, Bull. 3. pp. 433–540, Aug., and pp. 541–604, Oct., 1907.)—H. Abraham in his report to the Paris Congress of 1900, expressed a doubt whether from the result of all the determinations that had yet been made we could be sure of the value of v within 1 part in 1,000. The authors began their experimental work in Nov., 1904, and carried it on without interruption to the middle of 1907. They use the method of capacities. From the concordance of their experimental results they believe that the value of v is given by $v = 2{\cdot}9963 \times 10^{10}$ [cm. Int. ohm/sec.]$^{\frac{1}{2}}$, with a maximum inaccuracy of not more than 1 part in 10,000. The mean temperature at which the work was done was 20·0° C., and hence, reducing the above value to *vacuo* (assuming that the dielectric coefficient of air at 20·0° C., and 76 cm. pressure is 1·00055) we get $v_0 = 2{\cdot}9971 \times 10^{10}$. It is interesting to remember that J. J. Thomson and Searle obtained the value $2{\cdot}9960 \times 10^{10}$ for v in 1890. A very full discussion of the sources of error in the determination of capacity both in electrostatic and electromagnetic measure is given. The authors believe that the accuracy of their result exceeds the maximum they thought possible 3 years ago. They then regarded errors as negligible which they have taken into account, and much of the theoretical investigation of the sources of error has been made since the observations were completed. Until the value of the ohm is known with greater accuracy there is no present need for knowing v more accurately. When, however, the ohm becomes known to,

for instance, 1 part in 15,000, as it doubtless soon will be, it would be useful to carry out a new determination of *v*, using spherical, cylindrical, and plate condensers constructed with all possible accuracy, and so obtain a result which can be trusted to 1 part in 80,000. By analysing recent experimental results obtained for the velocity of light, the authors conclude that *in vacuo* it is $2\cdot9986 \times 10^{10}$ cm./sec., with a maximum inaccuracy of 1 part in 10,000. This differs from their value of v_0 by 5 parts in 10,000 with a possible uncertainty of 2 parts in 10,000. The remainder of the difference (1 in 3,000) may be due to uncertainty in the value of the International ohm or to errors in the determination of *v* and the velocity of light. There might possibly also be a small difference between the ratio of the units as measured by the methods and at the frequencies used by the authors and the velocity of light. These points have still to be determined. The contents of the paper are divided under seven heads. I. Introduction. II. Description of the condensers (spherical, cylindrical and plate). III. Electrostatic capacities. IV., V. and VI. Correction and sources of error for spherical, cylindrical and plate condensers. VII. Determination of capacities in electromagnetic measure. Many novel methods, both experimental and analytical, are described. The paper, therefore, has a great educational value, apart from the importance of the results obtained. A. R.

100. *The Various Methods of Determining "v."* **E. B. Rosa and N. E. Dorsey.** (Bureau of Standards, Bull. 3. pp. 605–622, Oct., 1907.)—A brief *résumé* is given of the various methods of determining the ratio of the electromagnetic to the electrostatic unit of electricity, and their relative accuracies are compared. The five fundamental methods were clearly stated by Maxwell and Fleeming Jenkin in 1868. The quantity method which was used by Weber and Kohlrausch in 1857, and by Rowland in 1875, is the most complicated and the least accurate. The e.m.f. method is better. It may be of service in giving us a more accurate value of the e.m.f. of the standard cell, taking *v* as known—for the value of *v* is probably known to a higher degree of accuracy than the value of the e.m.f. of the standard cell. The resistance method cannot be expected to give as accurate results as the more direct of the capacity methods. Seven capacity methods have been employed. The "ballistic galvanometer" method and the "steady deflection" method, are not so good as the "Maxwell bridge" and the "differential galvanometer" methods. The "Maxwell bridge" method was first employed by J. J. Thomson in 1883. It was then used by Himstedt, Rosa, Thomson and Searle, and Rosa and Dorsey. The "oscillatory discharge" method, the "rotating magnet" method, suggested by Andrew Gray, the comparison of capacity and resistance with alternating current by Wien's vibration galvanometer and the comparison of electromagnetic capacity with inductance by means of various bridge methods, are stated to be more complicated methods and not capable of such high accuracy. With the use of several different forms of absolute condensers, constructed as perfectly as possible, and measured by the "Maxwell bridge" or the "differential galvanometer" method, the authors believe that thoroughly trustworthy results can be obtained. There is no need to use any of the less direct and more difficult methods. A. R.

101. *Electrostatic Alternating and Rotating Fields.* **V. v. Lang.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2a. pp. 975–986, May, 1907.)—A horizontal circular cardboard disc is suspended by its centre in a horizontal electrostatic alternating field. Rods of some substance are placed near the opposite ends of a

diameter of the disc which makes an angle of 60° with the lines of force. When the field is excited, the disc rotates by a few degrees. When the rods are of insulating material, a diameter of the disc originally parallel to the lines of force is rotated towards the line joining the rods. The same thing happens when the rods are very thick and metallic, and very strongly when they are replaced by flames. The rotation is in the opposite direction when thin metallic rods are used. With imperfect conductors the effects are very uncertain, as they greatly depend upon their state of moisture. The effects may be explained by polarisation and the deformation of the field. The effect is made steadier by letting the disc hang inside a beaker. Flames in an electrostatic alternating field take a shape flattened in the plane of the lines of force. The field may be converted into a rotating one by attaching wooden boards to the metallic electrode plates, and at right angles to them, on one side. E. E. F.

102. *Rotating Electrostatic Field.* **A. Lampa.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2a. pp. 987–994, May, 1907.)—Describes a new method of obtaining a rotating electrostatic field from an alternate-current transformer. It is a modification of the method in which v. Lang attached plates of wood at right angles to the plates of a condenser, so as to form a kind of box. The author makes up a similar square box entirely of metallic plates which do not touch each other, and connects the condenser plates with the other plates by means of wooden rods. These must have a certain conductivity to produce the necessary lag. The indicator is a paper tube suspended within the box, which also must have a certain degree of moisture. It rotates in one sense within the box, and in the other sense just outside at the corners. The author gives the theory of the contrivance. E. E. F.

103. *Atmospheric Electricity at Battle Harbor, Labrador, during Solar Eclipse of Aug. 30, 1905.* **J. E. Burbank.** (Terrestrial Magnetism, 12. pp. 97–104, Sept., 1907.)—The author was chief of a party sent by the Carnegie Institution of Washington, to Battle Harbor, an island 6 miles east of the Labrador coast, much exposed to violent storms. The district is within the belt of maximum polar light. The observations were made by Bowen and Homrighaus on a level 100 ft. above the sea. The potentials were determined with the aid of an Exner portable electroscope with leaves of Al-foil and a collector consisting of a copper rod coated with radio-tellurium, readings being taken every minute. The potential oscillated about a mean of 80 volts/m. until 8.20 a.m., 10 min. after maximum obscuration; it fell rapidly then to 23 volts at 8.32 a.m., and rose rapidly again to 70 volts at 8.40, and further to 140 volts at 11.40 a.m.; the morning was clear and normal. The specific electric conductivity was measured in absolute electrostatic units by a Gerdien instrument whose working is explained. High conductivities of the air were observed, those for negative electricity being on the whole greater than those for positive electricity. During the eclipse the conductivity for negative electricity remained constant: that for positive electricity decreased during the latter part of the eclipse, rising slowly till noon when it reached the value for negative electricity. The observations were difficult; moisture seemed to have the same effect on both positive and negative electricity, and the eclipse effect is difficult to explain. H. B.

104. *Diurnal Variation of Spontaneous Ionisation in closed Metallic Vessels.* **T. F. McKeon.** (Phys. Rev. 25. pp. 399–421, Nov., 1907.)—Very

largely a repetition of the work of Campbell and Wood [Abstract No. 651 (1907)]. One metallic cylinder is enclosed within another; if the outer is connected to earth and the inner to an electrometer, the presence of an electric charge is indicated. The variations of this for long periods are investigated. It is found that the charge reaches a maximum after the first few hours, then falls off, but never dies out altogether, or changes sign. In McLennan and Burton's experiments the ionisation did not fall off with time [Abstract No. 1936 (1904)]. When the experiments have been continued for 20 hours or more, the influence of two weak but very definite sources of ionisation manifest themselves. The effect of one is a progressive increase or decrease; superposed on this there is a second change of periodic character which has 2 maxima and minima every 24 hours. [The local times at which these occur do not appear to be the same as in Wood and Campbell's paper.] Various pairs of metals are used; in the author's experiments the inner cylinder acquires a positive charge, in McLennan and Burton's a negative charge, when the inner and outer cylinders are the same kind of metal. Richardson has suggested that the explanation of the effects is to be found in the ionisation caused by certain solar rays in the upper regions of the atmosphere, thereby producing a change in the potential gradient near the surface of the earth. It is thought that the present experiments support this view, particularly the fact that great changes occur immediately after a fall of rain. R. S. W.

105. *Electric Phenomena of the Atmosphere.* **A. Schuster.** (Journ. de Physique, 6. pp. 937–950, Dec., 1907. Paper read before the Soc. franç. de Physique, April 5, 1907.)—Discourse on the theory of terrestrial generation of atmospheric electricity in consequence of air movements caused by solar radiation. Measurements of the changes in electric charge during varying types of weather appear to show that the order of quantities involved is competent to produce the observed phenomena. Thus during rainstorms Elster and Geitel have often found electrifications of 6×10^{-15} c.g.s. per sec., and on one occasion it amounted to 76×10^{-15} c.g.s. per sec. The sign of the charge was sometimes positive, at others negative. According to this theory there should be an excess of positive ions in the atmosphere, tending to increase the conductivity, and to the belief that the vertical current should remain sensibly constant, which is supported by the results of recent balloon ascents. That the phenomena depend in some manner on solar radiation is proved by the increase of magnetic perturbations in times of great solar activity, and by the occurrence of definite magnetic storms contemporaneously with large spot outbreaks, but it is not yet clear whether a direct relation can be stated between details of either phenomenon. Measures of the flocculous areas of calcium vapour which exist in the spot belts, as shown by spectroheliograph pictures, show that they vary with the spot areas approximately; and as they are rich in ultra-violet light it may be that this radiation affects the ionisation of our atmosphere to some extent. If the geographical axis be taken as identical with the magnetic one, we may regard the electromagnetic variations as depending solely on the latitude and local time; but if the two axes are treated as independent, we shall find a period depending on the time of the meridian containing the magnetic axis. The importance of continuity of observations under *fixed* conditions is strongly urged, as variation even of adjustments often leads to uncertain corrections being applied. C. P. B.

DISCHARGE AND OSCILLATIONS.

106. *Anode Rays.* **E. Gehrcke** and **O. Reichenheim.** (Phys. Zeitschr. 8. pp. 724–726, Oct. 24, 1907. Paper read before the 79 Naturforscherversamml., Dresden. Communication from the Physikal.-Techn. Reichsanstalt.)—A continuation of the work mentioned in Abstracts Nos. 869 and 1180 (1907). The Doppler-effect has been observed with lithium and sodium, and hence the mean velocity is found to be 10^7 cm./sec. Simultaneously the anode fall of potential is measured by means of an exploring electrode 2 cm. from the anode, and then, by assuming that the kinetic energy of the rays is due to falling freely through this potential, e/m is found. No justification for this assumption is given. For a fall of 2,200 volts e/m for sodium is $0{\cdot}45 \times 10^3$. As e/m for hydrogen is $9{\cdot}5 \times 10^3$, it follows, if e is the same for both, that the mass of the particles from sodium is 21 times the corresponding quantity for hydrogen. Measurements are also made of e/m by using the magnetic deflection and the anode fall of potential. The ratios of the masses of the particles to the mass of a hydrogen atom are Na $= 22$, Li $= 8{\cdot}6$, Sr $= 90$, using in every case the mean magnetic deflection, and taking the electric charge on the Sr as $2e$. It thus appears that the ions are the atoms of the active metal. R. S. W.

107. *Rays of Positive Electricity.* **E. Gehrcke** and **O. Reichenheim.** (Phys. Zeitschr. 8. pp. 726–728; Discussion, pp. 728–729, Oct. 24, 1907. Paper read before the 79 Naturforscherversamml., Dresden.)—A brief account of the various positive rays that appear in discharge tubes. In the *discussion*, **W. Wien** expresses the opinion that Goldstein's K_1-rays are the same as the heavy negative ions observed by himself and Thomson when measuring the magnetic deflection of the canal rays. R. S. W.

108. *Wehnelt Kathode in a High Vacuum.* **F. Soddy.** (Nature, 71. pp. 53–54, Nov. 21, 1907.)—According to previous experimenters the Wehnelt lime kathode gives greater saturation currents the lower the gas pressure, and the current is supposed carried by electrons emitted from the metal. The author finds, if the residual gas is more completely removed by his calcium furnace, that the kathode ceases to act. He therefore concludes that electronic emission cannot account for more than a negligible fraction of the total current; the remainder is carried by the residual gas. R. S. W.

109. *Red Phosphorescence Colours in Vacuum Tubes.* **E. Gehrcke** and **O. Reichenheim.** (Deutsch. Phys. Gesell., Verh. 9. 21. pp. 593–597, Nov. 15, 1907. Communication from the Physikal.-Techn. Reichsanstalt.)—Lilienfeld has drawn attention to a red phosphorescence which is seen in vacuum tubes when strong currents are sent through [Abstract No. 1071 (1907)]. From the direction and amount of deflection by a magnetic field he has concluded that it is caused by positive ions or even positive electrons. Working under similar conditions the authors show that it is caused by kathode rays coming from secondary kathodes on the glass walls. R. S. W.

110. *Red Phosphorescence Colours in Vacuum Tubes.* **E. Goldstein.** (Deutsch. Phys. Gesell., Verh. 9. 21. pp. 598–605, Nov. 15, 1907.)—Using an induction coil and working with smaller currents, conclusions are reached similar to those arrived at by Gehrcke and Reichenheim [see preceding

Abstract]. By using a small condenser in addition to the coil the colour of the phosphorescence can be changed. It is concluded by all three authors that the red colour is caused by slowly-moving kathode rays.
R. S. W.

111. *Kathode-fall and Spectra of Compound Gases.* **G. Gehlhoff.** (Ann. d. Physik, 24. 3. pp. 553–578, Nov. 26, 1907. Dissertation, Berlin, 1907.)—Capstick has shown that measurements of the kathode fall of potential are difficult in compound gases on account of decomposition [Abstract No. 88 (1899)]. This produces intermittence of the current. For the same reason the spectrum of such gases is difficult to obtain. In the present paper a long wire kathode is used; this can be moved through small distances so as to bring the exploring electrode in different parts of the negative glow. With the pressures used it is necessary to have this electrode on the edge of the Crookes space. Near the kathode is a very fine capillary tube, through which the gas under investigation is sucked so as to keep a steady flow past the electrode. The dimensions and pressures are so arranged that with the steady flow the pressure of the gas is a few mm. in the tube. A telephone placed in the circuit is then silent and the kathode-falls is readily measured. Kathodes of Pt, Cu, and Zn are used, and the following gases are investigated: CO, CO_2, NO_2, NO, NH_3, N_2O_4. The kathode-falls using Pt electrodes are, in the same order, 490, 475, 387, 365, 370, 381 volts. CH_4 could not be used, as it caused a deposit of carbon on the electrode. The wave-lengths of some of the brightest lines are also given.
R. S. W.

112. *New Kathode Dark Space in Helium and Hydrogen.* **F. W. Aston.** (Roy. Soc., Proc. Ser. A. 80. pp. 45–49, Dec. 9, 1907.)—Using the guard-ring kathode of previous experiments [Abstract No. 1072 (1907)], a new dark space, between the Crookes space and the kathode, has been observed. It is clearest in helium and hydrogen, and has not hitherto been observed in other gases. The greatest length of the space is about 1 mm. In the previous paper it has been shown that the force X in the Crookes space is given by $X = (8\pi cx/\lambda)^{\frac{1}{2}}$, where $c =$ current density, $x =$ distance from outer edge of space, $\lambda =$ velocity of a positive ion in unit field at the prevailing pressure. If D, the length of the Crookes space, be substituted for x, the field just outside the kathode is obtained; since D is roughly proportional to λ, this field is independent of pressure and proportional to $c^{\frac{1}{2}}$, indicating that the fall across d, the width of the new dark space, is constant. This is probably the fall of potential through which the electrons must move in order to attain sufficient energy to ionise molecules by collision. The theory shows that d will be greatest for low current densities. Experiments show that the fall of potential is constant over the range of pressures and currents used; for hydrogen it is 15 volts, for He 30 volts. Assuming for the value of e $3{\cdot}4 \times 10^{-10}$, and for e/m $1{\cdot}7 \times 10^{7}$, in the usual units, the minimum energy required to ionise an atom of hydrogen is $1{\cdot}7 \times 10^{-11}$ ergs, and the minimum ionisation velocity $2{\cdot}25 \times 10^{8}$ cm./sec. Theory enables the following effect to be predicted: Let d be the distance through which the ions must move freely to ionise the gas. If d is smaller than the mean free path of an electron, we should expect just beyond d a maximum ionisation and a corresponding maximum light, gradually fading as we recede from the kathode. When a point $2d$ from the kathode is reached the electrons formed by collisions at d will have attained the ionisation velocity, so that there

should be another maximum; similarly another at 8*d*, and so on. In helium, at comparatively high pressures and low current densities, three distinct maxima and traces of a fourth have been seen. Also the fall of potential across these is apparently the same for each, hence the initial velocity of the electrons starting from the kathode must be negligible, and the values of the minimum energy and velocity, already given, become absolute. In other gases either this energy is so small that *d* is too small to be detected or the electrons start from the kathode with sufficient velocity to ionise at the outset.
R. S. W.

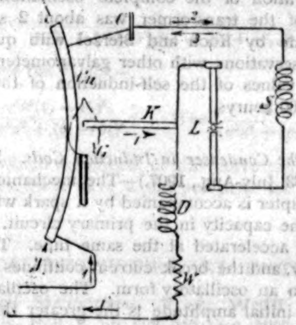
113. *Discharge of Electricity from Pointed Conductors differing in Size.* **J. Zeleny.** (Phys. Rev. 25. pp. 305–333, Nov., 1907.)—To enable experimental results to be compared with any proposed mathematical analysis of the mechanism of the discharge from points, it is essential that these results be obtained under conditions that can be completely stated and so permit of exact duplication. These conditions are fulfilled if wires of sufficiently great length have their ends either plane or hemispherical, and are contained in a large vessel. The other electrode is a plane which is earthed through a galvanometer and telephone in series; the former measures the current, the latter tells when it is steady. The preliminary tests show that the apparatus may be looked upon as a very long point discharging to an infinitely large plane. The curves expressing the experimental results fall into two classes—(*a*) potential-current curves for the same point, (*b*) curves connecting potential and diam. of the point for the same current. The smoothness of the latter shows that, for the point positive, minor irregularities of the surfaces have little influence. The relation between the current from a point and its potential can be represented, for the positive discharge, by Warburg's formula $C = aV(V - M)$, where a is a constant, $M =$ minimum potential required to produce a discharge, $V =$ potential for the current C. This is extended to include points of all sizes by changing a to $a(1 + bd)$, where $d =$ diam. of the point and a and b are new constants. In the experiments d has a maximum value of 2 mm. Voltages may be measured with fair accuracy by measuring the current flowing from a point of known size, using the curves of the present paper. The results for the point negative are not so consistent. Corrections are made for pressure and temperature.
R. S. W.

114. *Stratifications in the Electric Spark.* **L. Magri.** (Accad. Lincei, Atti, 16. pp. 680–683, Nov. 17, 1907.)—The spark takes place between cadmium electrodes in a cylindrical steel vessel having a quartz window. The pressure of the air in the tube is increased up to 10 atmos., and a rotating mirror is used for obtaining photographs, which exhibit the successive oscillations of the spark. As the pressure is increased from that of the atmosphere the spark becomes more steady in position and its brilliancy increases; also the air which is rendered luminous contracts towards the axis of the spark. When a pressure of 7–8 atmos. is reached the spark on its first half-oscillation presents striations similar to those observed in the vacuum tube, but their distinctness diminishes rapidly in succeeding oscillations. The striations are not so regularly spaced as those observed in the vacuum tube. In the photograph reproduced in the paper seven striations may be distinguished in the first half-oscillation and five in the second, while in the third they become so confused as to be hardly distinguishable.
S. G. S.

115. *The Electric Arc between Metallic Electrodes.* **W. G. Cady and H. D. Arnold.** (Amer. Journ. Sci. 24. pp. 383–411, Nov., 1907. Electrician, 60. pp. 296–298, Dec. 6; 371–372, Dec. 20, and pp. 407–409, Dec. 27, 1907. Abstract. Phys. Zeitschr. 8. pp. 890–906, Dec. 1, 1907.)—Two distinct types of arc can exist between iron electrodes in air. When the current is small the arc is in the first stage. It then passes through a critical point, somewhat similar to the hissing point of the carbon arc, to its second stage. Evidence from the loss of weight of the electrodes, the spectrum of the arc and the temperature of the anode, shows that the first stage is characterised by the absence of vaporisation of the positive electrode. Experiments are described on the change from the glow discharge to the arc in free air between iron, platinum, and copper electrodes. Attempts were made to identify the two stages for arcs between different metals, but both stages could be maintained steadily only in the cases of copper and of iron. In nitrogen at low pressures the glow and both stages of the arc were observed between a carbon kathode and anodes of lead, silver, and carbon. There is reason to believe that similar results can be obtained with most other metals. Platinum, and iron free from traces of oxide, did not show a stable first stage under any conditions. The diminution in the p.d. between the arc terminals in passing through the critical point from the first to the second stage is attributed partly to a decrease in the thermal e.m.f. at the anode, and partly to increased conductivity of the arc vapour. There is some evidence of a connection between the critical point and the melting-point of the material of the anode; but it is not well marked, and it is likely to be masked by effects due to the physical condition of the surface of the anode. The statical characteristics of the iron arc are discussed together with the probable form of the equation connecting voltage, current and length. A series of experiments was carried out on electrical oscillations in arcs with iron, copper, and silver anodes. At a current a little below 2 amps. on the second stage, the iron arc rotates and emits a whistling sound. This is often attended by spasmodic changes back to the first stage. The application of Lecher's test for continuity led to observations on the "singing" iron and copper arcs, the energy expended in the oscillations during both stages of the arc being observed by means of a bolometer. To test the continuity of arcs between various metals by a method more free from error, a new manner of connecting the bolometer was devised. The results Lecher attained with large currents were verified. The iron arc, however, became continuous on the first stage, while in the case of arcs with copper or silver anodes, marked oscillations were detected as the current decreased. [See also Abstract No. 870 (1907).] A. R.

116. *Low-pressure Mercury Lamp for Large Currents.* **J. E. Lilienfeld.** (Phys. Zeitschr. 8. pp. 776–777; Discussion, pp. 777–778, Oct. 24, 1907. Paper read before the 79 Naturforscherversamml., Dresden.)—It is pointed out that for a given expenditure of energy in the current the proportion of light emitted to heat produced increases as the vapour pressure is decreased from high values, and has a maximum at a particular pressure; for this pressure, of course, the efficiency of the mercury lamp is a maximum. A lamp is described in which the discharge passes through a narrow tube running through a large outer tube. Condensation of the mercury vapour occurs in the outer tube, and the greater the surface of the latter the greater the cooling and the lower the working pressure. By a suitable design the pressure corresponding to the maximum efficiency of the lamp may be obtained. S. G. S.

117. *High-frequency Arc in the Shunt Circuit of a Duddell-Poulsen Arc.* **J. Sahulka.** (Elektrotechn. Zeitschr. 28. pp. 1063–1064, Oct. 31, 1907.)—The arrangement employed by the author is shown in the Fig. Here Cu is a water-cooled copper tube connected to the neutral of a 220-volt supply, K a 7 mm. solid carbon connected to the negative lead (—ᵛᵉ to Cu tube). The arc is formed in a coal-gas flame G. The direction of the direct current is shown by the arrows marked 1. W is a resistance (88 ohms), D a choke coil, C = 0·1467 mfd., while the inductance (value not given) is made up of several coils of wire. The high-frequency arc L occurs between two 5-mm. solid carbons only 2 cm. long (to keep the resistance low). The direct current before oscillations were set up was 5 amps., with an arc p.d. of 40 volts, but diminished on the oscillations starting. The measurements made included the direct current i_1, the rectified p.d. e_1 at G, the total p.d. e at G (due to direct current and superimposed pulsations), the current i_2 in the shunt circuit, the p.d. (ε) at condenser C, the p.d. Λ at L; l is the arc length at L in mm. The results are set forth in the following table :—



Experiment No.	Observed.							Calculated.			
	i_1	e_1	e	i_2	ε	Λ	l	e_2	ε_2	$\sim$	w
1	5·0	40	40	—	—	—	—	—	—	—	—
2	3·2	102	130	4·0	200	40	9·5	80·6	172·0	25,230	10·0
3	3·5	92	135	4·1	200	35	6·0	98·1	177·6	25,050	8·5
4	3·4	92	155	4·6	230	30	4·0	124·7	210·8	23,670	6·5
5	4·0	76	110	4·2	195	25	2·0	79·5	179·6	25,140	5·9
6	4·1	70	102·5	4·4	202	20	1·2	74·9	189·2	25,230	4·5
7	4·0	63	105	4·5	205	15	0·3	84·0	195·1	25,020	3·3

e_2 is the alternating p.d. at G, ε_2 that at C, and w the resistance of the arc L in ohms.

L. H. W.

118. *Slow Condenser Oscillations.* **O. Wiener.** (Phys. Zeitschr. 8. pp. 752–755; Discussion, p. 755, Oct. 24, 1907. Paper read before the 79 Naturforscherversamml., Dresden.)—Description of a method for establishing slow condenser oscillations with a vibration period of about 1 sec., and an account of their observation with a suitable galvanometer and electrometer. By means similar to those employed by W. König [see Abstract No. 688 (1899)], in which, using the secondary coil of a large spark inductor and a Leyden jar, slow oscillations were obtained which could be investigated by means of Lichtenberg figures on a moving piece of dielectric, the author obtained with the 50-cm. inductor of the Leipzig Institute oscillations of about 45 per sec., the Leyden jar employed having a capacity of about 0·002 m.f.d. The obtaining of oscillations of long period is a question of increasing the capacity. Later, the secondary coil of a transformer was found more suitable, and as galvanometer an Edelmann's small oscillograph, whose period was $\frac{1}{50}$ sec., was used. On switching off the applied e.m.f. the spot of light went quickly back to the zero point, did not remain there, but swung further on and executed several clearly perceptible slow if also strongly damped vibrations. The duration of the complete oscillation with 31 mfd. and the secondary coil of the transformer was about 2 sec.; with a simple transformer coil made by Koch and Sterzel with quadruple capacity it was about 1 sec. Observations with other galvanometers and electrometers are described. The values of the self-induction of the condensers varied from 400 up to over 700 henrys. J. J. S.

119. *Function of the Condenser in Induction Coils.* **M. La Rosa.** (N. Cimento, 14. pp. 26–53, July-Aug., 1907.)—The mechanical separation of the terminals of an interrupter is accompanied by a spark whose duration is the shorter the greater the capacity in the primary circuit. The falling off of the break current is accelerated at the same time. The spark is always extinguished suddenly, and the break current continues for a short time in the primary circuit in an oscillatory form. The oscillations are sinusoidal and damped. Their initial amplitude is the greater the shorter the break spark, *i.e.*, the larger the capacity employed. E. E. F.

120. *Electric Oscillators.* **J. A. Fleming.** (Electrician, 59. pp. 936–939, Sept. 27; 976–979, Oct. 4, and pp. 1016–1018, Oct. 11, 1907. Écl. Électr. 53. pp. 192–195, Nov. 9, and pp. 233–237, Nov. 16, 1907.)—In this excellent series of articles the author discusses the theory of the electric oscillator and the production of electric waves thereby. The first part deals with the action of a Hertzian oscillator, and, starting with the two circuital relations giving the values of Curl H and Curl E, shows how to obtain expressions for the magnetic and electric forces at any point in space round it. The second part, in like manner, discusses the closed or magnetic oscillator, and expressions are obtained for the forces and radiative power. In the third part combinations of open and closed oscillators are discussed, and the elementary theory of the *bent* oscillator which radiates unsymmetrically is given. Though the mathematical theory includes the vector potential, the points under discussion are also illustrated by analogies and numerical examples. **W. M. Madden, J. A. Fleming.** (Electrician, 60. pp. 175, 176 *et seq.*)—Some controversial correspondence relating to the analogies employed and to other points. E. H. B.

121. *An Error in Bjerknes' Method of Measuring Damping of Electrical Oscillations.* **M. Wien.** (Phys. Zeitschr. 8. pp. 764–766; Discussion, p. 766, Oct. 24, 1907. Paper read before the 79 Naturforschersversamml., Dresden. Écl. Électr. 53. pp. 267–269, Nov. 23, 1907.)—The Bjerknes method of determining the damping of an electrical oscillation depends on the action of the oscillation on a resonating circuit and the determination of the resonance curve by this means. The expression for the current in the

resonating system in its relation to the decrements θ_1 and θ_2 and to the tuning $x = 1 - \frac{n_1}{n_2}$ (n_1 and n_2 being frequencies) is—

$$I_2^2 = C . \frac{\theta_1 + \theta_2}{\theta_1\theta_2(4\pi^2x^2 + (\theta_1 + \theta_2)^2)}.$$

By taking different values of x, θ_1 and θ_2 may be determined. In giving this formula Bjerknes and Drude have assumed that the coupling is negligibly weak, *i.e.*, that the second circuit does not react on the first, which is not usually the case. If k be the coefficient of coupling the following is more exact :—

$$I_2^2 = C \frac{\theta_1 + \theta_2}{[\theta_1\theta_2 + A]\,[4\pi^2x^2(1 + B) + (\theta_1 + \theta_2)^2]},$$

in which A and B have the values—

$$A = \frac{\pi^2k^2(\theta_1 - \theta_2)^2}{4\pi^2x^2 + (\theta_1 - \theta_2)^2}; \qquad B = \frac{4\pi^2k^2}{4\pi^2x^2 + (\theta_1 - \theta_2)^2}.$$

Curves are given in which the effects of this correction are shown. Under certain circumstances these have a sharper peak for close than for loose coupling. J. E.-M.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

122. *Standard Cell Specifications.* **F. A. Wolff** and **C. E. Waters.** (Bureau of Standards, Bull. 3. pp. 623–640, Oct., 1907.)—The specifications given by the authors are for Clark and Weston cells, and are based upon previous specifications [see Abstracts Nos. 2811 (1904), 1432 and 1904 (1906), and 471 (1907)], and upon work done at the Bureau of Standards. The purification of the mercury is effected by double distillation *in vacuo*, or by distillation in a current of air under reduced pressure. The amalgams are made by electrolysis, thus rendering unnecessary the preparation of the pure metals, methods for which are, however, given. For the purification of the sulphates of cadmium and zinc detailed instructions are given, but in both cases crystallisation is the final purifying process. Mercurous sulphate may be prepared (*a*) by electrolysis; (*b*) by chemical precipitation, mercurous nitrate and sulphuric acid being used; (*c*) by the treatment of mercury with sulphuric acid containing a small percentage of nitric acid; (*d*) by reduction of mercuric sulphate with mercury; and (*e*) by recrystallisation of commercial mercurous sulphate. In each case the acid is removed by washing with a neutral saturated solution of cadmium sulphate (if Weston cells are to be set up) or zinc sulphate (for Clark cells). For facility in filling and sealing the H type of cell is recommended, the platinum terminals being amalgamated by electrolysis of a solution of mercurous nitrate in dilute nitric acid. The cells are hermetically sealed. F. E. S.

123. *Manganin Resistances and Humidity.* **E. B. Rosa** and **H. D. Babcock.** (Bureau of Standards, Bull. 4. pp. 121–140, Dec., 1907. Paper read before the Amer. Phys. Soc. Electrician, 60. pp. 162–164, Nov. 15, 1907.) [See Abstract No. 1392 (1907).]—The authors criticise the statement made by Jaeger and Lindeck [Abstract No. 1564 (1907)], that the variation of manganin resistances with atmospheric humidity need cause no anxiety to the owners of such resistances. In a particular case at the Bureau of

Standards the variation of resistance of a standard coil between Jan. 1 and May 1, 1907, was about 35 parts in 100,000, the change occurring in the course of two weeks of damp weather, with the humidity averaging 64 per cent. The atmospheric conditions were not more severe than frequently prevail in other places, except that the transition from dry to humid was more sudden. The work at the Bureau of Standards tends to confirm the work of Jaeger and Lindeck, not only that manganin is very well adapted for resistance standards, but that the method of mounting them and protecting them from the oxidation of the air or oil, by shellac or varnish, is very satisfactory, *provided that they are also protected from the effects of atmospheric humidity.* The author compares the atmospheric humidities of London, Berlin, and Washington for each of the four seasons of the years 1904 and 1905, and shows that the differences of climate and differences in the methods of heating the laboratory buildings combine to make any effect of varying moisture much greater in Washington than in Berlin; but, it is urged, the value of a precision standard should not depend on the climate, nor require a climate of uniform humidity to enable it to remain constant. F. E. S.

124. *Thomson-effect in Mercury.* **C. Schoute.** (Archives Néerlandaises, 12. pp. 175–190, 1907.)—Describes a null method of measuring the Thomson-effect. If a current traverses a conductor, the heat developed in an element of volume $q\,dx$ in time dt is—

$$(i^2w/qJ)dx\,.\,dt + i\sigma(du/dx)dx\,.\,dt,$$

where i is the current, u the temperature, w the resistance, σ Thomson's constant, q the sectional area, and J the mechanical equivalent of heat. The direction of the current can always be chosen so that in the portion of the conductor under consideration the total heat is zero. This method avoids the necessity of having to wait for equilibrium, and the sum of temperature variations can be taken over a long stretch of the conductor. In the case of mercury, the proper current would, however, be too feeble for measurement. The author therefore keeps a length of the conductor between two fixed temperatures at either end, and measures the difference produced by sending a current in either direction. The temperatures are measured by means of the thermoelectric force against platinum. The σ observed ranges from $-1{\cdot}48 \times 10^{-6}$ at 305° abs. to $-2{\cdot}48 \times 10^{-6}$ at 427° abs., and appears to be more or less proportional to the absolute temperature, as supposed by Thomson. [See also Abstract No. 2255 (1905).] E. E. F.

125. *Iron-Constantan Peltier-effect.* **P. Cermak.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2a. pp. 657–668, April, 1907. From the Physikal. Inst. der k.k. deutsch. Univ., Prag. Ann. d. Physik, 24. 2. pp. 351–356, Nov. 12, 1907. Extract.)—The Peltier-effect of iron-constantan couples was measured between 0° and 560° C. by means of Lecher's thermoelectric calorimeter. The following are the values obtained for the constant at various temperatures:—

Temperature.	0° C.	20°.	130°.	240°.	320°.	560°.
Mean value of Peltier-effect per coulomb in gm.-cals. $\times 10^{-3}$	3·1	3·6	4·5	6·2	8·2	12·5

The value obtained at the temperature of the room, 20° C., viz., $3{\cdot}6 \times 10^{-3}$, is in good agreement with that previously found by Lecher, $3{\cdot}4 \times 10^{-3}$. J. J. S.

126. *Change of Ni-Cu Peltier-effect with Temperature.* **K. Rziha.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2a. pp. 715–722, April, 1907. From the Physikal. Inst. der k.k. deutsch. Univ., Prag.)—The change with temperature of the Peltier-effect in a Ni-Cu junction was observed when the latter was heated in a porcelain oven whose temperature was raised by means of an electric current. An iron-constantan couple was used to indicate the temperature. The Peltier-effect investigated was not measured directly but by means of the rise of temperature caused by it at two junctions; this produced a thermo-e.m.f in an iron-constantan couple, the amount of which was indicated by the movement of a galvanometer needle. It was found that the Ni-Cu Peltier-effect increased steadily as the temperature was raised from 18° C. to about 260° C., the increase being directly proportional to the rise of temperature. Above 250° the value decreased again till about 350°, when it again commenced to increase and rose steadily as before till nearly 770° C. The two last observations, at 770° and 800°, appeared to show the commencement of another decrease, but these were somewhat uncertain owing to the effect of oxidation of the thin iron wire used. The method used was not one of great accuracy, the principal source of error being due to the change of the specific heat of Cu and Ni at high temperatures which is not yet known. Loss of heat due to radiation also occurred. The experiments, however, show the general course of the changes of the Peltier-effect as the temperature is raised in the case of the particular combination investigated. J. J. S.

127. *Thermoelectric Behaviour of Metals in Solutions of their own Salts.* **W. D. Henderson.** (Phys. Rev. 25. pp. 353–361, Nov., 1907.)—An investigation was made to determine (1) the direction of the thermo-e.m.f. of cadmium amalgam in a solution of cadmium sulphate; (2) the relation between the thermo-e.m.f. and the concentration of the electrolyte, and also (3) to compare the thermo-e.m.f. due to a given difference of temperature with the e.m.f. due to a corresponding difference of concentration. The electrodes were placed at the bottom of the branches of a U-tube which formed the cell, the two legs of the cell being joined by a siphon provided with a stopcock. Temperatures from 0° to 30° C. were employed and readings of e.m.f. were made by means of an Otto Wolff potentiometer reading directly to 0·00001 volt. It was found that: (1) Cadmium amalgam in a solution of cadmium sulphate gives between 0° and 30° a thermo-e.m.f. directed in the external circuit from the warm electrode to the cold—*i.e.*, the warm electrode is the kathode. In the case of silver the opposite is the case, the cold electrode being the kathode. (2) The thermo-e.m.f is a function not only of the temperature, but also of the concentration of the electrolyte, an increase in concentration producing an increase of e.m.f. In the case of silver the opposite holds true. (3) Within the range of temperature employed the thermo-e.m.f. due to a given difference of absolute temperature is nearly ten times as great as the e.m.f. due to a corresponding difference of concentration. Therefore the thermo-e.m.f. observed cannot be accounted for on the assumption of an increase of osmotic pressure, since, according to the theory, a given increase of osmotic pressure due to a given difference of absolute temperature should be equal to that due to a corresponding difference of concentration. J. J. S.

128. *Wehnelt's Interrupter.* **F. Piola.** (N. Cimento, 14. pp. 54–72, July–Aug., 1907.)—Pellat observed the paradoxical fact that when an impedance is introduced into a circuit containing a Wehnelt interrupter, the mean intensity of the current is considerably increased. A similar and even more parodoxical phenomenon is that the current, whether mean or effective, is always increased while the apparatus acts as a simple electrolytic cell, before the e.m.f. has attained the amount necessary for interruption. The author regrets Pellat's own interpretation of this, and points out that the break spark makes the point red hot and depolarises it. The higher the temperature, the more thorough will be the depolarisation, and the less the polarisation on renewal of contact. Whatever diminishes the temperature reduces the mean current. A magnetic field surrounding the point has the effect of making the action irregular, and cannot be recommended. E. E. F.

129. *Automatic Current Intensity Regulator.* **O. Sackur.** (Zeitschr. Elektrochem. 13. pp. 674–675, Oct. 11, 1907. Electrician, 60. p. 170, Nov. 15, 1907. Abstract.)—The author combines a Bredig-Hahn current manometer [see Abstract No. 132 (1901)] with a mercury gauge, for the purpose of securing constant current intensity, when the e.m.f of the current source, *e.g.*, a battery, fluctuates. The apparatus, which is made by Franz Hugershoff, of Leipzig, is intended for electrolytic work and currents up to 10 amps. A gas voltameter with two Ni electrodes discharges its gas through a tube which above ends in a fine capillary; the gas is, therefore, throttled, and the gas pressure (Poiseuille) is proportional to the current intensity. A tube system branches off from the wider part of the outlet tube. This system consists of several continuous U's, the first of which is charged with absolute alcohol, while the other parts are filled with mercury. When the mercury oscillates, it makes contact either with an adjustable needle in the higher limb or with a wire in the lower limb. These contacts close shunts for the currents, and the connections through sliding resistances are such that, when the battery p.d. sinks, the voltameter current is strengthened, and the mercury thereby displaced. H. B

130. *New Selenium Cell.* (Elect. Rev., N.Y. 51. p. 595, Oct. 12, 1907.)—W. J. Hammer has patented a form of selenium cell for which robustness of construction and permanency are claimed. The central support of the selenium is a fused quartz tube coated with a thin film of aluminium, over which the selenium is applied in a thin uniform layer, which latter is itself covered with a thin transparent film of aluminium. The complete cell is sealed into a quartz tube, the two Al films being used as the electrodes of the cell. **W. J. Hammer.** (Ibid. p. 638, Oct. 19, 1907.)—Hammer explains more fully that the complete sealing-in and protection from moisture afforded by the construction of his cell preclude the development of what is sometimes erroneously termed a photo-electric effect, *i.e.*, that a current is produced by the cell itself when illuminated; such a current, when observed, is due solely to absorption of moisture, which turns it into a photo-electric cell. L. H. W.

131. *New Influence Machine.* **H. Wommelsdorf.** (Ann. d. Physik, 24. 3. pp. 483–491, Nov. 26, 1907.)—The behaviour of an influence machine, in which the sectors are imbedded in a solid insulating material, is described, the machine being constructed in accordance with principles given in a previous paper [see Abstract No. 1882 (1907)]. A comparison with the older machines is made, which shows its superiority in output. Also a table of absolute results is given. With a simple machine consisting of a single fixed, and a single rotating plate the maximum current is 175 micro-amps., and e.m.f.

135,000 to 150,000 volts, when the diam. of rotating plate is 55 cm. ; with a double machine with plates of the same diam., one being fixed and the other rotating, the maximum current is 350 micro-amps., and maximum e.m.f. 140,000–150,000 volts. S. G. S.

132. *Direct-reading Vacuum-meter.* **G. Berndt.** (Elektrotechn. Zeitschr. 28. p. 1124, Nov. 21, 1907. Communication from the Phys. Laborat. des Polytechn., Cöthen.)—The hot-wire ammeter previously described [Abstract No. 1585 (1907)] can, as in the case of Voege's [Abstract No. 1484 (1906)], be used as a vacuum gauge or meter. In the present case a 16-cm. silver wire of 0·27 mm. diam. with a current of 0·3 amp. gave 1 scale division for about 0·05 mm. pressure. The pressures were approximately measured by comparison with the discharge in a Geissler tube and gave the following readings :—

Ammeter Divisions.	Pressure.
2·5	Atmospheric.
2·6	Banded discharge (about 1 cm.).
6·0	Stratified „ („ ⅓ mm.).
24·0	Commencement of kathodic light.
30·0	Kathode region filled with green light.
32·5	Green light at anode.
37·0	Whole tube green, weak at anode.
40·0	„ „ „ , stronger.
46·6	„ „ „ , very strong.

L. H. W.

ALTERNATING CURRENTS AND MAGNETISM.

133. *Resistance of Coil for Alternating Currents.* **A. Sommerfeld.** (Phys. Zeitschr. 8. pp. 805–809, Nov. 1, 1907.)—The calculations of the resistance of a coil for high-frequency currents made by A. Battelli [Abstracts Nos. 958, 1430, and 1899 (1906)] are criticised on the grounds that Rayleigh's formula for the resistance of a straight wire is improperly applied. The author finds that the effective resistance is proportional to the square root of the frequency, and not the fourth root. By means of his formula he calculates the change of resistance for various frequencies, and finds that the results are more nearly in agreement with the experimental results than are those of Battelli. S. G. S.

134. *Short-period Magnetographs.* **Y. Kashiwagi.** (Coll. Sci. and Engin., Mem. Kyōtō, 1. 3. pp. 217–227, 1906–1907.)—The author describes the principles governing the construction of the new magnetic variometers which he has recently constructed and tested. After premising that the period may be diminished either by decreasing the moment of inertia of the movable part, or by increasing the moment of force acting on the moving part, he shows that the practical limit of efficiency is reached before the desired short period is obtained when the inertia is gradually reduced. He therefore only considers the improvements connected with modifications of the acting couples. Sketches are given to illustrate special arrangements of field magnets for both vertical and horizontal force magnetographs, and reproductions of actual photographic traces compared with those given by other types of apparatus. For the horizontal force he was able to obtain a period of 2·0 sec. for a sensibility of 2·6γ; for the vertical force a period of 3·0 sec. for $S = 1{\cdot}9\gamma$.

C. P. B.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

135. *Absorption of Hydrogen by Metallic Films.* **W. C. Baker.** (Phys. Rev. 25. pp. 422–428, Nov., 1907.)—Heald has found that certain metallic films, formed by volatilising metals in a partial vacuum, absorb hydrogen. An attempt is here made to investigate the matter quantitatively. Films of silver, iron, or platinum are made by spluttering from a kathode in a hydrogen-free atmosphere. Hydrogen is then admitted, but no absorption whatever occurs. R. S. W.

136. *A New Element, Lutecium, obtained by the Resolution of Marignac's Ytterbium.* **G. Urbain.** (Comptes Rendus, 145. pp. 759–762, Nov. 4, 1907. Chem. News, 96. pp. 271–272, Dec. 6, 1907.)—The author has fractionally crystallised the nitrate of ytterbium, carrying out the operation 22 times. The absorption spectra of the first fractions show the bands of thulium, and therefore these were rejected. The remaining fractions, which should consist of ytterbium, were analysed and the atomic weight was found to increase progressively from 169·9 to 173·8. The arc and spark spectra of the last fractions showed new lines which are absent from or at most very feeble in the first fractions. These phenomena the author attributes to the presence of a new element, lutecium (Lu), and he defines its spectrum as containing about 34 lines. For the remaining element after ytterbium has been purified of thulium and lutecium he proposes the name neo-ytterbium (Ny). Of Lecoq de Boisbaudran's ytterbium bands the author apportions the α and β to neo-ytterbium and the γ to lutecium. The atomic weight of Ny cannot be far from 170, and that of Lu not much above 174. E. C. C. B.

137. *Adsorption of Iodine by Carbon.* **O. C. M. Davis.** (Chem. Soc., Journ. 91. pp. 1666–1683, Oct., 1907.)—The author describes investigations on the adsorption of iodine, dissolved in various organic solvents, by means of charcoal (animal, sugar, and cocoanut). The effect of temperature on the amount of adsorption is found to be very small, but that of time is well marked. The adsorption, although rapid at first, proceeds slowly for lengthened periods after a "surface equilibrium" has been maintained, proving that both surface action and diffusion are concerned in the mechanism of adsorption. The adsorbing values of animal and sugar carbon are roughly the same, whilst that of cocoanut carbon is much less than these. The amount of adsorption is not independent of the nature of the adsorbing surface for identical surface area, but is specific, depending on the nature of the solvent and the adsorbing solvent. T. H. P.

138. *Adsorption Formulæ.* **J. W. McBain.** (Chem. Soc., Journ. 91, pp. 1683–1687, Oct., 1907.)—The results of recent work on adsorption have been expressed by either of the two following formulæ, which are applicable to gases or solutions :—

$$(1)\ x/m = \beta c^{1/p} = \beta\,[(a-x)/v]^{1/p}\,;$$
$$(2)\ \lambda = v/m\,.\,\log a/(a-x) = \alpha(a/v)^{-1/n}$$

[compare Freundlich, Abstract No. 1234 (1907)], where x is the amount of substance adsorbed, a the total amount of that substance, $(a-x)/v = c$ its concentration in the fluid phase, m the weight of adsorbing substance, and λ, β, a, p, and n are constants. The author shows that there are serious disadvantages inherent in the use of the λ-formula, whereby an equilibrium is referred to a parameter a/v with which it has no apparent connection. This expression, introduced to represent the amount of adsorption, does not lead to any definite number characteristic of each set of substances, and moreover, its results are irreconcilable with each other and with experiment. T. H. P.

139. *Pyrophoric Properties of some Uranium Compounds.* **A. Colani.** (Annal. Chim. Phys. 12. pp. 59–144, Sept., 1907.)—This lengthy research is chiefly of purely chemical interest. Uranous arsenide, U_3As_4 (or U_3As_2), when in the fused form emits very voluminous sparks of high temperature at the least shock; the sparks will ignite the mixed gases of a Bunsen burner, the behaviour being thus similar to that of uranium carbide as studied by Chesneau (Comptes Rendus, 122. p. 471, 1896). Uranium antimonide shows similar properties. Two pieces of this alloy when knocked together will easily light a Bunsen burner and even a spirit lamp. The alloy gives off sparks under the file, but it is too friable to be usefully applied in practice.

L. H. W.

140. *Chemical Action of Radium Emanation.* II. *On Solutions containing Copper, and Lead, and on Water.* **A. T. Cameron** and **W. Ramsay.** (Chem. Soc., Journ. 91. pp. 1593–1606, Sept., 1907.)—The authors confirm the previous results of Ramsay [see Abstract No. 1641 (1907)] and suggest, in explanation of them, the following hypothesis: (1) That helium and the a-particle are not identical; (2) that helium results from the "degradation" of the large molecule of emanation by its bombardment with a-particles; (3) that this "degradation," when the emanation is alone or mixed with oxygen and hydrogen, results in the lowest member of the series to which the emanation undoubtedly belongs, namely, helium; (4) that if particles of greater mass than hydrogen or oxygen are associated with the emanation, namely, liquid water, then the "degradation" is less complete, and neon is produced; (5) that when molecules of still greater weight and complexity are present, as is the case when the emanation is dissolved in a solution of a copper salt, the product of the "degradation" of the emanation is argon. It also appears as though the copper were involved in this process of degradation, being reduced to the lowest member of its series, namely, lithium, and it is suspected that, at the same time, sodium is produced in much greater quantity than lithium. Experiments on the gases evolved from thorium nitrate show that CO_2 is one of the products; this might be interpreted by the same hypothesis, in supposing carbon to be formed by the degradation of thorium, the highest member of the carbon series. T. H. P.

141. *Colouration of Precious Stones under Radio-active Influences.* **D. Berthelot.** (Comptes Rendus, 145. pp. 818–820, Nov. 11, 1907.)—Colourless quartz and fluorite after an exposure of more than a year did not develop the slightest colour under the influence of a neighbouring tube containing radium bromide. A violet amethyst (manganese) quartz decolourised by heat was, however, recoloured in this way, and a violet fluorspar from Weardale behaved in the same way. A green emerald from the Tyrol, decolourised with liberation of an odour of acrolein by the action of heat, was not recoloured, and a similar negative result was obtained with a white emerald. Saturated solu-

tions of manganese acetate and chloride did not show any gain or loss of colour. Crystals of potassium sulphite which were coloured green by radium could be washed colourless by means of chloroform, which left a green residue on evaporation. No colouration was produced on crystals previously ignited, and the colour is therefore due to organic impurities on the surface of the crystals. T. M. L.

142. *Preparation of Colloidal Silver.* **N. Castoro.** (Gazzetta Chim. Ital. 37. 1. pp. 391–395, 1907.)—Colloidal silver solutions may be readily prepared by boiling ammoniacal silver nitrate solution with acraldehyde and a small quantity of gelatin solution. In this way, concentrated solutions of colloidal silver, having the colour of bromine, may be prepared. These solutions may be kept for years without losing their properties or changing their colour. T. H. P.

143. *Rapid Method for obtaining certain Cerous Salts directly from Cerium Dioxide.* **L. Marino.** (Gazzetta Chim. Ital. 37. 1. pp. 51–54, 1907.)—Cerium dioxide may be readily converted into cerous salts by the use, as reducing agent, of quinol, which becomes converted partly into quinhydrone and partly into benzoquinone. Thus cerous sulphate, $Ce_2(SO_4)_3, 5H_2O$, is obtained by heating a mixture of equal amounts of cerium dioxide and quinol with rather more than the calculated quantity of dilute sulphuric acid. Cerous chloride may be prepared in a similar manner. This reaction may be advantageously employed in the separation of cerium from thorium, since calcined thorium dioxide is difficultly soluble in dilute acids. T. H. P.

144. *Testing Carbons for Electrometallurgy.* **F. A. J. Fitzgerald** and **J. Forssell.** (Amer. Electrochem. Soc., Trans. 11. pp. 317–324; Discussion, pp. 324–327, 1907.)—The authors have tested some carbons in the laboratory of the National Carbon Co., of Cleveland, Ohio. The furnace was green; the carbons, up to 8 ft. in length, were amorphous or graphitised (Acheson); they formed furnace terminals, or were placed in the outer circuit, or were partly in the furnace, without forming electrodes. The connection between electrode and copper lead should be made by graphite. The ordinary powdered graphite is, however, unsuitable; decomposed carborundum, Acheson's unctuous graphite, and specially prepared and heated Ceylon graphite will answer. The graphitised carbons are better heat conductors, and cause more loss of heat by conduction than amorphous carbons. There is a considerable p.d. between the part outside the furnace and the part inside, both with the monophase 60-∼ currents used and the direct currents of special tests, and this was finally explained as due to the distortion of the equipotential planes by the granular carbon resistor surrounding the terminal. Observations on small-sized carbons must not be considered to hold for large-size electrodes. In the *discussion*, **Sperry** and **C. Hering** touched upon the difficulties of such tests. H. B.

145. *Electrical Reduction of Titaniferous Iron Ores.* **G. Gin.** (Amer. Electrochem. Soc., Trans. 11. pp. 291–293; Discussion, pp. 293–294, 1907.) Electrician, 60. p. 295, Dec. 6, 1907. Abstract.)—A brief account of smelting experiments conducted by the author in 1901 in Norway, and in 1906 in the laboratory of W. Borchers in Aachen. It would appear that one must only allow two-thirds as much lime as titanic acid, while as much lime as silica present is allowed—not to render the mass too refractory.

At Aachen currents of 500 amps. at 65 volts were employed; the temperature (Wanner pyrometer) rose to 1,900° C. All the Ti, 16 per cent. in the ore, went into the slag. The *discussion* was confined to a few remarks by **J. W. Richards,** who read the paper. H. B.

146. *Borides and Silicides.* **O. P. Watts.** (Univ. of Wisconsin, Bull. No. 145. Engineering Series, 3. 3. pp. 251–318, Nov., 1906.)—Attempts to make a silicide of phosphorus in the electric furnace met with failure. Silicides of Cu, Fe, Ni, and Mo were successfully prepared from the respective sulphide ores by simultaneous reduction with a silicate, by calcium carbide or Al, in the electric furnace. The total yield based on the metal and non-metal was a little over 50 per cent. If carbon or a carbide be used, the silicide absorbs carbon if the metal is capable of uniting with carbon; but the product can be obtained free from sulphur by the use of lime or Al. The existence of a silicide of molybdenum, $MoSi_2$, is indicated, prepared by heating in the arc furnace a mixture of molybdic acid, silica, boric anhydride, copper, aluminium, cryolite, and lime. The corresponding method, *i.e.*, the simultaneous reduction of the oxide of the metal with boric anhydride, was found to be quite unsuitable for the preparation of borides. A possible silico-boride of iron is indicated, but results varied greatly. In one case the formula of the product approximated to $Fe_8Si_4B_3$. The corresponding results with Cr and Mo were inconclusive. A full bibliography of the subject is given, and considerable data of the arc furnace, from which it is seen that the resistance of the arc depends on its length, current strength (increase of which increases effective cross-section of arc), temperature of furnace, quantity and nature of vapours in furnace. The arc tends to maintain a constant ratio between its own resistance and that of the remainder of the circuit, or an arc of fixed length tends to maintain a constant voltage. Varying the external resistance 900 per cent., the max. variation in voltage of arc was 14·1, and the mean 1·8 per cent. Using electrodes of Acheson graphite, the max. currents permissible on account of their oxidation outside the furnace were as shown in the following table, for 20 minutes' heating:—

Diameter, inches............	1	1¼	1½	2
Amps.	400+	650+	900	1,600

F. R.

147. *Silicides of Molybdenum, Tungsten, and Tantalum.* **O. Hönigschmid.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2b. pp. 921–932, June, 1907. From the Chem. Laborat. d. k.k. deutsch. Univ., Prag.)—The silicides $MoSi_2$, WSi_2, and $TaSi_2$ were prepared from the oxides of the metals by allowing them to react with sand, flowers of sulphur, and aluminium powder. An excess of silicon was always present, but a fair degree of purity was attained by chemical treatments, which, as well as analytical methods, are detailed. All three silicides are only with difficulty attached by reagents. The specific gravities are respectively at 0° C., 5·88, 9·3, 8·83. The question as to whether lower silicides will be formed if the proportion of oxide to silica be increased is to be investigated. F. R.

148. *Action of Carbon on Magnesia at High Temperatures.* **O. P. Watts.** (Amer. Electrochem. Soc., Trans. 11. pp. 279–288; Discussion, pp. 288–289, 1907.)—At high electric-furnace temperatures magnesia and carbon have been observed apparently to react as a black deposit is formed. It is found that

this is an intimate mixture of carbon and MgO, and its formation is explained as due to the reaction $MgO + C = Mg + CO$ occurring at high temperatures and reversing at lower temperatures. In the course of the experiments it was found that magnesia containing iron oxide can be freed of this impurity by heating in an electric resistor furnace, and also that MgO is reduced more readily by certain carbides than by pure carbon. The carbides of Fe, Cr, and Ni are particularly active in this respect. Siloxicon and carborundum also reduce MgO more readily than carbon. In the *discussion* **J. W. Richards** pointed out the probable analogy between the above action between carbon and MgO and that between the carbon dissolved in iron and SiO_2 in the blast furnace. F. R.

149. *A Practical Limitation of Resistance Furnaces.* **C. Hering.** (Amer. Electrochem. Soc., Trans. 11. pp. 329–336; Discussion, pp. 336–337, 1907. Abstracts in Elect. Rev., N.Y. 50. pp. 793–795, May 18, 1907. Electrochem. Ind., N.Y. 5. pp. 223–224, with Discussion, June, 1907. Elect. Engin. 39. pp. 751–753, May 31, 1907.)—When we have a liquid conductor carrying a large current the electric forces tend to compress the conductor more particularly at the points where the section is small. In practice this "pinch" tends to rupture the circuit and prevents the satisfactory operation of liquid resistance furnaces. It therefore is an important factor which has to be taken into account by designers. If a portion of the channel, for instance, is made smaller than the rest for the purpose of increasing the temperature locally it is highly probable that this phenomenon will defeat that purpose. The author advises that the channel should be made as uniform and as free from obstructions as possible. When possible a liquid flux should be used to dissolve any solid floating particles and to float or wash them away. When a solid resistance is obtainable it is always preferable to a liquid one. [See also Abstract No. 1681 (1907).] A. R.

150. *Electric Tube Furnace for High-temperature Measurements.* **S. A. Tucker.** (Amer. Electrochem. Soc., Trans. 11. pp. 303–306, 1907. Electrochem. Ind., N.Y. 5. p. 227, June, 1907.)—The furnace described consists of a tube made of agglomerated carbon, 54 cm. long, 2·5 cm. inside diam., 3·85 cm. outside diam. except the central 9 cm., which is 3·1 cm. diam. Connections are made by means of water-cooled brass end-pieces, either soft-soldered to the carbon tube or packed with thin foil or gauze. The heat insulation has been found to be best achieved by means of petroleum coke. With 6 to 8 volts 1,500° was reached in 7 min. with a max. current of 500 amps., and 1,688° in 10 min. With 15 volts a temperature of 2,952° was reached in 14 min., the max. current being 850 amps. The special object of the arrangement is to avoid the interference of fumes with temperature observations. For the determination of a melting-point a hole in a disc is covered with the material to be studied, and one observer watches the melting occur whilst another takes the temperature by means of an optical pyrometer from the other end of the furnace. F. R.

151. *Granular Carbon Resistance Furnace.* **S. A. Tucker.** (Amer. Electrochem. Soc., Trans. 11. pp. 307–314; Discussion, pp. 314–315, 1907. Electrochem. Ind., N.Y. 5. pp. 227–228, June, 1907.)—In the furnace described the resistor is crushed coke, and this surrounds a graphite or other crucible; the current is led in by ordinary arc-furnace electrodes. The first time the coke is used it must be slowly heated until all fumes are driven off and requires a much higher starting voltage. To prevent local heating of the crucible the parts nearest to the electrodes may be packed about with charcoal. Temperatures exceeding 2,000° were observed, and when petroleum coke mixed with graphite was used in place of the gas coke, and a graphite tube conveying a current of hydrogen led from the crucible, the observed temperature attained in about 38 min. was about 2,400°. It is considered that the actual temperature would be about 2,700°, but that there was, in spite of the precautions, some obscuring by fumes. Crystalline titanium carbide, titanium, and chromium were satisfactorily prepared. In the *discussion* the **Author** said, in reply to **Hering,** that on a commercial furnace of this type a flexible connection to one of the electrodes would undoubtedly be necessary. F. R.

152. *Reduction of Oxides, &c., by Metallic Calcium.* **F. M. Perkin.** (Faraday Soc., Trans. 3. pp. 115–117; Discussion, pp. 117–118, Oct., 1907.)—It was not found possible to obtain boron free from calcium by reducing boric anhydride with calcium. The violence of the reaction is diminished by the addition of a little CaO to the charge, and the crucible may for convenience be lined with lime and borax, or lime and sodium silicate. The amount of Ca in the product was 24 to 25 per cent. Upon reducing sand with Ca turnings, a little Si was obtained. The reaction between PbS and Ca was probably the formation of a thioplumbate or plumbite, but no free lead was obtained. Hæmatite was readily reduced, with formation of metallic iron and CaO. From pyrolusite and chromium sesquioxide, metallic Mn and Cr respectively were reduced. The chief difficulty in using Ca for reduction is in most cases the violence of the reaction. The infusibility of the CaO is an additional difficulty. If the reaction between Al and a metallic oxide does not take place readily, there appears to be a distinct advantage in the use of a mixture of Ca and Al. In the *discussion,* **A. K. Huntington** explained the greater violence of the reactions with Ca as compared with corresponding reactions with Al, as due to the fact that although the heats of combustion were practically the same, yet the amount of oxygen required by one part of Al was much greater than that required by one of Ca (0·88 and 0·4 respectively). Calcium had been tried for pouring steel, but the oxide formed appeared to remain in the steel and give trouble. In reply to **Weston,** the **Author** stated that he was unable to procure finely-divided Ca. The drawback to the production of Si by reduction of kieselguhr with Al was that kieselguhr was such a fine and light powder that undesirably large crucibles had to be employed. F. R.

153. *Aluminium Carbide.* **H. R. Ellis** and **F. E. Weston.** (Chem. News, 96. pp. 269–270, Nov. 29, 1907.)—The authors have prepared aluminium carbide from wood charcoal, sugar carbon, and certain hydrocarbons. Using sufficiently finely powdered carbon and Al, the reaction, which is exothermic, once started proceeds throughout the mass. The impurities associated with the carbide are alumina and aluminium nitride, and hydrogen and CH_4 and probably a little C_2H_2 (not over 0·2 per cent.) are given off. The evolution of gas when the carbide is in contact with water occurs very slowly. F. R.

154. *Metallography of the High-carbon Iron Alloys.* I. *Separation of Graphite.* **E. Heyn** and **O. Bauer.** II. *Solidification of White and Grey Iron.* **E. Heyn.** (Stahl u. Eisen, 27. pp. 1565–1571, Oct. 30, and pp. 1621–

1625, Nov. 6, 1907.)—The first paper gives the results of experiments in which the amount of carbon which had separated out from two series of samples at various temperatures during slow cooling from the molten condition was observed. The samples were analysed after quenching from chosen temperatures. In one series the total carbon was about 8 per cent., and Si about 4 per cent.; in the other, total carbon about 8, and Si about 1·5 per cent. In both series the greater part of the separation of graphite occurred in the interval of 80° to 40° immediately below the completion of solidification of the eutectic. The behaviour of the alloy containing 8·12 per cent. C and 4·16 per cent. Si was practically as eutectic; its solidification temperature was 1,148°–1,188°. Thus Si undoubtedly diminishes the eutectic carbon percentage, and also, by reducing the tendency to supercooling, assists the system to take up the stable equilibrium (graphite-containing) condition. Upon annealing for short periods at various temperatures irons which had cooled slowly from the molten condition, a possible slight increase in the amount of graphite in Si-rich samples was observed, but increase occurred in low-Si irons, even after heating to 1,180°. The iron did not melt at this temperature. The melting-point of grey iron, the stable form, is higher than the solidification- and melting-points of white iron, the labile form, which agrees with the general law followed by stable and labile modifications. The author also accepts the view that the action of Si is catalytic. The second paper is a note on some recent papers on the subject of the iron-carbon diagram. The author does not agree with Goerens' [Abstract No. 912 (1907)] view that kish is thrown violently out of solidifying cast iron on account of its low specific gravity, but considers the action to be due to gases set free. The paper is fully illustrated with diagrams and photomicrographs.
F. R.

155. *A Volumetric Study of Cast Iron.* **H. M. Lane.** (Amer. Soc. Mech. Engin., Proc. 29. pp. 467–475, Mid.-Nov., 1907.)—Some of the peculiarities of iron castings are explained by a consideration of the volumes of the so-called impurities present. The volume of impurities in a No. 2 foundry iron containing 6·93 per cent. by weight is 85·73 per cent. This throws some light on the complete change of properties brought about by the addition of only 7 per cent. of impurities to soft Swedish iron. F. C. A. H. L.

156. *Present Sources and Uses of Vanadium.* **J. K. Smith.** (Amer. Inst. Mining Engineers, Bull. 17. pp. 727–782, Sept., 1907.)—Particulars are given of the recently opened deposit of vanadium sulphide ore in South America, which show that it is probably of practically inexhaustible extent, and the company owning the mine have works of a daily capacity of 2,000 lbs. of vanadium alloys, such as ferro-vanadium of 88 per cent. V. A table showing the principal components of the chief ores, in percentages, is given. When calcined the new sulphide ore contains 58 per cent. vanadic oxide. Test figures are given for vanadium steels, and compared with figures for carbon and nickel steels. Similar examples have already been referred to. [See Abstract No. 1482 (1906).] F. R.

157. *Lead Oxide and Silica.* **W. Mostowitsch.** (Metallurgie, 4. pp. 647–655, Oct. 8, 1907. Communication from the Metallhüttenmänn. Laborat. d. Kgl. techn. Hochschule, Berlin.)—The author finds that from 700° to 800° C. —chiefly about 750°—PbO and SiO_2 combine to form silicates from the solution of PbO in lead glass. The solubility of PbO falls with temperature. The lead silicates are slightly unstable, and at 500°–600° are easily reduced. The application of the data in the reduction processes is discussed. F. R.

158. *Copper-Bismuth Alloys.* **K. Jeriomin.** (Zeitschr. Anorg. Chem. 55. 4. pp. 412–414, Oct. 12, 1907. Metallog. Communication from the Inst. f. anorg. Chemie d. Univ., Göttingen.)—Bismuth dissolves more than 0·25 and less than 0·5 per cent. Cu, and Cu dissolves more than 0·25 and less than 0·5 per cent. Bi. The beginning of solidification is a smooth curve, falling almost straight from 100 Cu to 20 Cu at 795°, and almost straight from 4 Cu at 600° to almost 0 Cu. The completion of solidification is a horizontal line at about 270°. It is suggested that the difference between the author's and Gautier's results is due to the presence of copper oxide in the latter's work. F. R.

159. *Cobalt-Tin Alloys.* **F. Ducelliez.** (Comptes Rendus, 145. pp. 431–433, Aug. 19, and pp. 502–504, Sept. 9, 1907.)—Upon attack by hydrochloric acid these alloys leave a residue approximating in composition to Co_3Sn_2; upon treatment with nitric acid, alloys containing over 62 per cent. Sn leave a residue of composition corresponding to CoSn. The following table summarises the results :—

Sn, per cent.	Constitution.	Properties.	
0			
	Co and Co_3Sn_2	Magnetic. Brittleness increasing.	
57·65	......Co_3Sn_2	......Density 8·862.	
	Co_3Sn_2 and CoSn	Very brittle	Non-magnetic
66·76	......CoSn	......Density 8·950	
		Softer and less brittle	
85	CoSn and Sn		
		Malleable	
100			

[See also Abstract No. 1421 (1907).] F. R.

160. *Alloys of Potassium with Aluminium, Magnesium, Zinc, Cadmium, Bismuth, Tin, and Lead.* **D. P. Smith.** (Zeitschr. Anorg. Chem. 56. 1. pp. 109–142, Oct. 28, 1907. Metallog. Communication from the Inst. f. anorg. Chemie d. Univ., Göttingen.)—The thermal analyses [see Abstracts Nos. 1516 (1905) and 826 (1906)] of these alloys are described, the results being substantiated as far as possible by microscopic examination. Potassium is practically immiscible with Al or Mg in the liquid state at temperatures just above their melting-points. No compounds are formed in this series. Potassium and zinc are immiscible at 600° C. At 585° C an unstable form of the compound KZn_{13} is deposited, but is transformed into the stable αKZn_{13} at slightly lower temperatures. Potassium and cadmium are immiscible between the limits of composition 17 and 99 atomic per cent. K. The equilibrium diagram shows a maximum at 487° C. corresponding to the formation of a compound KCd_{11} which reacts with the potassium-rich liquid at 487° C. giving the compound KCd_7. Bismuth is completely miscible with potassium in the liquid state. The compounds K_3Bi and KBi_2 correspond to maxima at 671° C. and 554° C. respectively. The compound K_3Bi_2 and possibly K_9Bi_7 are also formed. βK_3Bi undergoes a transformation at 280° C. into αK_3Bi. The alloys of potassium with tin and lead were not completely studied because of the corrosion of the thermo-junction protectors. Potassium and tin are completely miscible in the liquid state, and form the compounds KSn_4, KSn_2, and probably K_2Sn, and KSn. βKSn_4 undergoes a transformation just above 400° C. The maximum of the diagram was not determined exactly, but the corresponding compound "*x*" may be identical with KSn_2. Potassium lowers the melting-point of lead to 275° C., the eutectic containing about 9 atomic per cent. K. Between 36 and 75 atomic per cent. K two liquid layers are formed from which the compound βK_2Pb crystallises at 568° C. and is transformed into αK_2Pb at 876° C. The compounds KPb_2, KPb_4, and a compound "*x*," not completely investigated, are also formed. The paper contains nine diagrams and a table comparing the alloys with the corresponding ones of sodium. [See Abstracts Nos. 1991 (1905), 1182 and 2159 (1906).]

F. C. A. H. L.

161. *Tungsten Steels.* **T. Swinden.** (Iron and Steel Inst., Journ. 73. pp. 291–324; Discussion, pp. 325–327, 1907. Metallurgie, 4. pp. 349–371, June 8, 1907.)—The author experimented on a series of nine steels, containing about 3 per cent. tungsten, and from 0·144 to 1·24 per cent. carbon, all other elements being low. Mechanical tests, microstructure and cooling curves are given in detail, the steels being dealt with after forging, rolling, and annealing at 950°. The tenacity and elastic ratio are much higher than for the corresponding carbon steels, whilst the ductility is about the same. The maximum tenacity occurs at about 0·9 per cent. carbon. When the cooling curves were taken from below a certain initial temperature—which is higher with increasing carbon—the critical points were the same as if no W were present. Assuming that the initial temperature is sufficiently high the critical points are as follows—

Carbon per cent.	Ar_1.	Ar_2.	Ar_3.	$Ar_{3,2}$.	$Ar_{3,2,1}$.
0 to 0·35	570°	Unaffected.	Becomes suppressed in normal position, reappearing at max. of Ar_1.	—	—
0·35 to 0·9	570°	—	—	Displaced towards Ar_1.	—
over 0·9	—	—	—	—	570°

The percentage of carbon in the eutectoid is practically the same as in carbon steels. The structures are practically as in the corresponding carbon steels, but rather finer. Incidentally, in the preparation of the ferro-tungsten, the possible existence of a compound, Fe_3W, is indicated. In the *discussion*, **C. Benedicks** drew further support from the author's data for the existence of "ferronite," and **G. B. Waterhouse** gave results which confirmed some of those in the paper.

F. R.

162. *Lead-Antimony Alloys.* **W. Gontermann.** (Zeitschr. Anorg. Chem. 55. 4. pp. 419–425, Oct. 12, 1907. Metallographic Communication from the Inst. f. anorgan. Chemie d. Univ., Göttingen.)—Describes the study of the alloys by the method of thermal analysis. Between 60 and 87 per cent. Pb, the alloys tend to segregrate into two layers. The Sb-rich alloys

have a double arrest-point at the eutectic temperature; the two points are 4–6° apart, and the lower arrest is of maximum duration in the alloy containing about 60 per cent. Pb. Since the solubility of large crystals is less than that of small crystals, the author considers that the equilibrium temperature of the system large crystals and liquid, will be higher than that of the system small crystals and liquid, and concludes that the eutectic temperature for liquid in contact with large crystals is higher than that for liquid in contact with small crystals. Although no eutectic crystallisation in the 1 per cent. alloys can be observed thermally, the microscope shows the presence of eutectic clearly. The author concludes that the metals separate from the molten alloys in a practically pure state. F. C. A. H. L.

163. *Iron-Tungsten Alloys.* **H. Harkort.** (Metallurgie, 4. pp. 617–631, Sept. 22; 639–647, Oct. 8, and pp. 673–682, Oct. 22, 1907.)—The work on the solidification of these alloys of almost pure Fe and W did not give very consistent results. The cause is discussed at length, and it is concluded that an oxide of iron forms one phase, and that a ternary system of uncertain composition is hence being dealt with. The transformation temperature Ac_2 is unaffected by addition of W to Fe. Ac_3 and Ar_3 are, however, considerably raised. These results are all somewhat irregular. The temperature from which the sample is cooled appears to be without effect. There is some support in the cooling curves for the existence of a compound Fe_3W in alloys containing 20 per cent. W and upwards. These views are also supported by the microstructure. With 15·4 per cent. W there is distinct evidence of mixed crystals in the alloys as made. After heating at 800° the presence of β-iron is recognised, and in two cases (0·7 and 3·38 per cent. W) there was slight separation of W [? W-containing constituent]. With higher percentages (11·7 and 19·6 W), there was no doubt of the occurrence of two constituents. Heating to 1,200° did not bring about the complete solution of this W-rich constituent. F. R.

164. *Iron-Molybdenum Alloys.* **Lautsch** and **G. Tammann.** (Zeitschr. Anorg. Chem. 55. 4. pp. 386–401, Oct. 12, 1907. Metallographic Communication from the Inst. f. anorgan. Chemie d. Univ., Göttingen.)—Gives the temperature-concentration diagram from 0 to 70 per cent. Mo. As at 42·5 per cent. Mo, the apex of the **V** curve at 1,354° is met by the apex of a triangle, a theory is advanced to explain this feature which is inadmissible in equilibrium according to the phase-rule. A compound of Fe and Mo is formed, which does not attain equilibrium with the Fe and Mo also present because the combination only occurs very slowly, hence the behaviour is as in a ternary system consisting of Fe, Mo, and an independent compound. If a mixture of Fe and Mo be heated very rapidly to 1,800°–1,850°, the compound is not formed, and the diagram is the simple form—two series of solid solutions with a eutectic. When the alloys are made by the aluminothermic method, the temperature reaches 2,300°, and the presence of the compound is well marked. The views are supported by other data and micrographs, but the formula of the compound is not established. F. R.

165. *Iron-Chromium Alloys.* **W. Treitschke** and **G. Tammann.** (Zeitschr. Anorg. Chem. 55. 4. pp. 402–411, Oct. 12, 1907. Metallographic Communication from the Inst. f. anorgan. Chemie d. Univ., Göttingen.)—The curve of the commencement of solidification is irregular, showing minima at about 15 and 40 per cent. Cr respectively (1,440°), and maxima at 30 and

90 per cent. Cr (1,450° and 1,610°). There is another irregular curve of halt-points, and a eutectic at about 1,260° between 30 and 60 per cent. Cr. These facts lead the authors to suggest that this system is one in which a compound of Fe and Cr forms with difficulty, and equilibrium is not attained, hence the behaviour is as in a ternary system of Fe, Cr, and a third body (X). [A somewhat similar case is mentioned in the preceding Abstract]. In the present case, however, corresponding to the complete miscibility of Cr with X and of Fe with X, the two surfaces representing these series will not extend into the binary systems, Cr-X and Fe-X. This type of ternary equilibrium has been described by Schreinemakers [see Abstracts Nos. 1128 (1905), and 1159 (1906)]. The conclusions are supported by the microstructure and by experiments on similar lines to those referred to in the preceding Abstract. Attention is drawn to the importance of the max. temperature reached in making Cr steels. F. R.

166. *Special Cast-irons, particularly Nickel Cast-iron.* **L. Guillet.** (Comptes Rendus, 145. pp. 552–558, Sept. 23, 1907.)—Alloys were made by adding amounts up to 50 per cent. Ni to a white iron (total carbon 3·2, graphite 0·052 per cent.), and up to 12 per cent. Ni to a grey iron (total carbon 2·789, graphite 1·697). With increasing Ni, pearlite soon disappears, sorbite appears, cementite begins partially to be of acicular form, later γ-iron appears, and also troosto-sorbite when sorbite disappears. Certain zones of the γ-iron are readily coloured by picric acid; the colouration is less with increase of Ni. Ni favours the separation of graphite. Similar experiments with additions of Mn instead of Ni, show that γ-iron is not formed, and generally sorbite is obtained. In general it is concluded that the elements which enter into solution in the iron (Ni, Al, Si) favour the separation of graphite, whilst those which form a double carbide (Mn, Cr) oppose the formation of graphite.

F. R.

167. *Electrical Conductivities of Potassium Chloride, Bromide, and Iodide in Ethyl and Methyl Alcohols.* **A. Stenquist.** (Arkiv Kem. Min. Geol., Stockholm, 2. No. 25. pp. 1-8, 1906.)—The author's measurements lead to the following values for the equivalent conductivity Λ and the temperature-coefficient C, the concentration being in each case 0·001 gm.-equivalent per litre: Potassium iodide, $\Lambda = 38{\cdot}5$, $C = 0{\cdot}0271$ in ethyl alcohol; $\Lambda = 88{\cdot}7$, $C = 0{\cdot}0188$ in methyl alcohol. Potassium bromide, $\Lambda = 36{\cdot}0$, $C = 0{\cdot}0234$ in ethyl alcohol; $\Lambda = 83{\cdot}0$, $C = 0{\cdot}0159$ in methyl alcohol. Potassium chloride, $\Lambda = 34{\cdot}5$, $C = 0{\cdot}0292$ in ethyl alcohol; $\Lambda = 81{\cdot}0$, $C = 0{\cdot}0180$ in methyl alcohol.

T. H. P.

168. *Water of Crystallisation.* **N. Morozov.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 38. No. 9. Physical Part, pp. 481–496, 1906.)—The author develops the view that in any horizontal row of the periodic system of the elements, the sum of the points of attraction of each element for electronegative (n) and electropositive (m) particles is a constant and equal to 8. So that, for lithium $n = 1$ and $m = 7$; for nitrogen, $n = 5$ and $m = 3$; for fluorine, $n = 7$ and $m = 1$, &c. The number of free (unoccupied) points of attraction of a chemical compound for electropositive particles should determine the number of water molecules with which the compound can combine in the crystalline condition. These views are illustrated by a number of examples, cases of incomplete hydration being explained as due to polymerisation of the salt molecules, which can combine with one another by means of the free points of attraction. T. H. P.

169. *Systems Non-homogeneous Thermodynamically.* **P. A. Gellvich [Helwig].** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 38. No. 4. Physical Part, pp. 225–240, 1906.)—The author studies the systematic errors due to the thermal heterogeneity of a body previous to observation. Special attention is paid to superfused liquids, which are regarded as mixtures of solid and liquefied particles. Consideration of the thermodynamic potential leads to the conclusion that this mixed state becomes the cause of the lowering of the temperature of unstable equilibrium of the liquid; the non-homogeneity, H, can be measured by the degree of superfusion. H is a function of several factors, notably the duration, *t*, of cooling of the liquid and its initial temperature T; if a rise of T is accompanied by increase of *t*, H has a maximum. Experiments with dinitrophenol show that a minimum of temperature corresponds with a maximum of H. The existence of liquid particles among the solidified elements may explain certain peculiarities of elastic solids.

T. H. P.

170. *Surface Tensions in the Critical Regions of Solutions.* **G. N. Antonov.** (Jurn. Russk. Fisik.-Chimičesk. Obšcestva, 38. No. 8. pp. 1258–1266, 1906.)—Results are given of surface-tension measurements of the systems: aniline and amylene at 19·8°, and *iso*butyric acid and water at 26·2° and at 22°. Comparison of the numbers obtained with those obtained by Konovalov. [(Konowalow) Abstract No. 1289 (1903)] for the vapour pressures of the same systems leads to the following conclusions: (1) Both the vapour pressure and surface-tension curves of binary mixtures of liquids in the neighbourhood of the critical condition run parallel to the axis of concentration, and (2) the coexistent phases of a binary mixture of liquids in the critical region exhibit equal surface tensions. This last conclusion is in disaccord with the views of Ostwald (Lehrbuch der allgem. Chemie, ii. p. 824) and Whatmough [Abstract No. 784 (1902)].

T. H. P.

171. *Diffusion of Electrolytes in Aqueous Solutions and in Gelatine.* **B. L. Vanzetti.** (Accad. Lincei, Atti, 16. pp. 655–657, Nov. 3, 1907.)—The formation of two separate zones of precipitate when, for example, barium chloride and silver sulphate solutions are allowed to diffuse into the opposite ends of a column of gelatine is explained by Buscaglioni and Purgotti (R. Ist. Bot. Pavia, Atti, New Series, 11, 1905) by the independent migration of the ions, which are assumed to obey Bunsen's law for the diffusion of gases. Bruni and Vanzetti (Accad. Lincei, Atti, 2. 15. pp. 705–715, 1906), on the other hand, regard the phenomenon as one of supersaturation. The author describes experiments similar to the above, in which the two salts diffusing into the gelatine are ammonium, potassium, rubidium or cæsium chloride (4 N-concentration), on the one side, and sodium platinichloride (0·5 N), on the other. With ammonium and potassium chlorides, the precipitated platinichloride is deposited at the same position in the gelatine column, and the same is the case with rubidium and cæsium chlorides, notwithstanding the varying ionic velocities of the different metals. Buscaglioni and Purgotti's hypothesis is hence untenable.

T. H. P.

172. *Diffusion of Electrolytes in Aqueous Solution.* **B. L. Vanzetti.** (Accad. Lincei, Atti, 16. pp. 696–702, Nov. 17, 1907.)—The author has measured the rates of diffusion of the potassium salts of Cl, Br, and I, employing a capillary tube of the form ⊓ filled with pure water only, the ends of which are immersed in aqueous solutions of the halogen salt and silver nitrate respectively, and determining the point at which the insoluble silver halide is formed. In this way the use of gelatine, which interferes with and obscures the reaction, can be dispensed with. The three potassium salts traverse almost equal distances in the tube in the same time, this distance being directly proportional to the velocity of migration of the ions.

W. H. St.

173. *Determination of Solubility by Pulfrich's Refractometer.* **Y. Osaka.** (Coll. Sci. and Engin., Mem. Kyōtō, 1. 8. pp. 265–278, 1906–1907.)—The relation between the indices of refraction of a mixture and its components may be simply expressed by : $ax + bx^2 = \delta - \delta' = \Delta$, where δ and δ' represent the angles directly observed on the divided circle in the Pulfrich refractometer when a solvent and a solution are examined, x the quantity of a solute in gm. per 100 c.cm. or 100 gm. of the solution, and a and b constants. Hence x may be calculated from the expression—

$$x = -a/2b \pm \sqrt{(a^2/4b - \Delta)/b},$$

where the lower sign is to be taken when a and b have different signs. Application of this method to saturated solutions gives accurate numbers for the solubilities of the dissolved substances.

T. H. P.

174. *Action of certain Substances on Potassium Iodide.* **B. Szilárd.** (Comptes Rendus, 145. pp. 483–485, Aug. 19, 1907.)—A large number of substances (oxides of iron, thorium, cobalt, copper, nickel, manganese, uranium, &c.), insoluble in water, have the property of acting on a solution of potassium iodide so as to set free a certain quantity of iodine. The action also occurs with certain minerals (tourmaline, cleveite, pyromorphite, samarskite, fergusonite, &c.), and is specially marked with some (but not all) uranium minerals, though it is not connected with the radio-activity of, for example, pitchblende.

D. H. J.

175. *Vapour Pressure.* II. **H. v. Jüptner.** (Zeitschr. Phys. Chem. 60. pp. 101–118, July 28, 1907.)—It has been shown previously [Abstract No. 1889 (1906)] that the factor f in van der Waals' vapour equation—

$$\log(p_k/p) = f(T_k/T - 1)$$

is not constant, but falls to a minimum and then increases, as T increases. The author brings forward the formula—

$$f = f_0 - aT/T_k + b/(1 - T/T_k),$$

which gives values of f agreeing very closely with those calculated from the vapour pressure curves for mercury, carbon dioxide, water, hydrogen, oxygen, nitrogen, and ammonia, the values of f_0, a and b being different for the different substances. At low temperatures (up to the minimum) the course of f is a straight line of the form : $f = f_0 + aT/T_k$. If this value is introduced into van der Waals' equation and the latter combined with the Clausius-Clapeyron equation, and the assumptions made that $v_k = 0$ and that the vapours follow the gas laws, the expression $\lambda = 4{\cdot}571(f_0 T_k - aT_k/T_k)$ is obtained for the latent heat of evaporation. [Compare Nernst, Abstract No. 1141 (1906).] Under the above assumptions, the Clausius-Clapeyron equation can be written in the form : $d(\log p)/d(\log T) = Q/A$, *i.e.*, the ratio of the latent heat of a process to the change of free energy is equal to the differential coefficient, $d(\log p)/d(\log T)$. If the heat of evaporation, $\lambda = RT \log(\pi/p)$ be defined as equal to the work yielded by the liquid in passing from the pressure π (that is, the internal pressure produced by the surface tension) into saturated vapour of pressure p, $f = \log(\pi/p_s)$, always assuming that the gas laws hold and that the volume of the liquid is negligible. (Ibid. 61. p. 76, Oct. 29.) **H. Happel.** A criticism. T. H. P.

176. *Vapour Pressure of Sulphur at Low Temperatures.* **H. Gruener.** (Amer. Chem. Soc., Journ. 29. pp. 1396–1402, Oct., 1907. Zeitschr. Anorg. Chem. 56. 1. pp. 145–152, Oct. 28, 1907. Contribution from the Chem. Lab. of Adelbert College.)—The vapour pressure of sulphur was determined by passing air, hydrogen, carbon dioxide, and steam over sulphur and condensing the volatilised material in a cold tube. The vapour pressures deduced from experiments with air and CO_2 were—

70°	0·00047 mm.	95°	0·0043 mm.
80°	0·0012	100°	0·0078
90°	0·0028		

The value obtained by steam distillation at 99·8° was 0·0069. T. M. L.

177. *Influence of Molecular Structure on the Viscosity of certain Isomeric Gaseous Ethers.* **F. M. Pedersen.** (Phys. Rev. 25. pp. 225–254, Oct., 1907. Paper read before the Amer. Phys. Soc., March 2, 1907.)—Experiments were made on eight ethers, which are vaporised and driven through a straight capillary tube, 84 cm. long, under known pressure conditions, at temperatures considerably higher than their boiling-points. The values found for $10^4\eta$ at 100° C. are: for methyl-ethyl ether 10·29, methyl-propyl ether 9·46; methyl-isopropyl ether 9·986, ethyl-propyl ether 8·636, ethyl-isopropyl ether 9·051, di-propyl ether 7·889, isopropyl-propyl ether 8·227, di-isopropyl ether 8·424. There is thus an unmistakable difference between the normal propyl and isopropyl ethers, which shows that a difference in molecular structure has a noticeable effect on the viscosity and thus on the size of the molecules, the molecules with the more numerous branches being smaller than those with the fewer or with no branches. The molecular volumes calculated from the viscosities are found to agree fairly well with those obtained by Kopp's rule. R. E. B.

178. *Electrolytic Dissociation of Partially Neutralised Weak Acids.* **Y. Mori.** (Coll. Sci. and Engin., Mem. Kyōtō, 1. 3. pp. 205–210, 1906–1907.)—The author's experimental results verify the following relations: (1) When a dilute solution of a weak monobasic acid has been neutralised to the extent of one-half by a strong monoacid base, the concentration of the hydrogen ions is independent of dilution and equal to the dissociation constant of the acid. (2) If the neutralisation amounts only to one-third, the concentration of the hydrogen ions is independent of the dilution and equal to twice the dissociation constant of the acid. (3) When a dilute solution of a mixture of two weak monobasic acids in equivalent proportions is neutralised to the extent of one-half by a strong monoacid base, the total concentration of the hydrogen ions is independent of dilution and equal to the square root of the product of the dissociation constants of the two acids. [Compare Osaka, Abstract No. 429 (1906).] T. H. P.

179. *Effect of Stress on E.M.F. of Iron.* **W. H. Walker** and **C. Dill.** (Amer. Electrochem. Soc., Trans. 11. pp. 153–167; Discussion, p. 168, 1907.) —Regarding the increase of potential (if any) of iron under stress as due to storing energy in the iron, the change should be +0·0000184 volt at the elastic limit (16,500 lbs. per sq. in.); this is for Swedish iron, E = 28,000,000 lbs. per sq. in. In experiments the change found was extremely small, not greater than —0·0001 volt usually, and in no case over —0·0004 volt, but always negative if apparent at all. A little above the elastic limit the potential rises suddenly by several hundredths of a volt, the amount depending upon the rate of straining, and vanishing abruptly upon ceasing to strain. This appeared not to be due to a heating effect. When iron was heated the change of potential was negative. Of many specimens studied the potentials of six reached constant values shortly after straining to rupture, the change amounting to from —0·0019 to +0·0077 volt. The single potential of unstrained iron was 0·156 volt. Similar results were obtained when the iron was strained by torsion. The cell used was Fe—FeSO$_4$—KCl—Hg. Greater p.d.'s were found between different parts of a hard-drawn steel wire than between an annealed and an unannealed piece of the same wire. F. R.

180. *Neutral Point of the Hydrogen Electrode.* **R. Lorenz** and **A. Mohn.** (Zeitschr. Phys. Chem. 60. pp. 422–430, Sept. 24, 1907. Laborat. f. physikal. Chemie u. Elektrochemie des Eidgen. Polytechnikums, Zurich, 1905–1906.)— From a series of measurements of the hydrogen electrode in various acid and alkaline solutions the authors obtain for the neutral point of the hydrogen electrode, *i.e.*, the potential of a hydrogen electrode at a pressure of 1 atmo. in pure water, as compared with a deci-normal calomel electrode, the value 0·75 volt. A. F.

181. *Electrochemical Behaviour of Gold and its Passivity.* **A. Coehn** and **C. L. Jacobsen.** (Zeitschr. Anorg. Chem. 55. 4. pp. 321–355, Oct. 12, 1907. Inst. f. physikal. Chemie, Göttingen, Dec., 1906.)—When the decomposition-potential curve of a solution of potassium gold cyanide, in which only monovalent gold is present, is determined, only one break is found. Several breaks are, however, found in the curve for solutions of gold chloride in which not only trivalent, but also monovalent gold ions exist. On further investigation it was found that gold as anode in solutions of gold chloride is not unattackable—a result which is not in harmony with previous investigations. As the anodic potential is increased (becoming more negative), the decomposition curve rises to a maximum and then rapidly falls and passes into an ordinary decomposition-potential curve showing a break at —1·78 volts, at which evolution of gas occurs. On retracing the curve from higher negative voltages to lower, the phenomenon of passivity is found. The passive gold, however, changes spontaneously into the active, and the current value for a particular voltage then rises to that for active gold. In potassium cyanide gold as anode dissolves in the monovalent form. With commercial KCN, but not with pure KCN, at small concentrations, the metal, however, becomes passive. This was found to be due to sodium ions, and the formation of the less soluble sodium gold cyanide. The authors believe that passivity is always brought about by the formation of such a sparingly soluble protective layer on the anode. A. F.

182. *The Nickel Oxide Electrode of the Jungner-Edison Accumulator.* **J. Zedner.** (Zeitschr. Elektrochem. 13. pp. 752–755, Nov. 22, 1907.)—In reply

to Foerster [see Abstract No. 1745 (1907)] Zedner states that the researches of Bellucci and Clavari on nickel oxides had not been published when he made his experiments [compare Abstracts Nos. 438 and 1490 (1906)]. Foerster does not give any proof of the existence of a solid solution of the peroxide NiO_2 in the overcharged electrode, however; nor does the author consider that Foerster's determination of the hydrate water in the nickel oxides is more reliable than his own. The second stage in the discharge curve is more easily explained by Zedner's assumption of a discharge of the occluded oxygen than by Foerster's suggestion of lower nickel oxides. Zedner is not himself in a position to continue his experiments. H. B.

183. *The High-tension Arc and the Fixation of Nitrogen.* **G. Brion.** (Phys. Zeitschr. 8. pp. 792–799, Oct. 24, 1907. Paper read before the 79 Naturforscherversamml., Dresden.)—The author accepts Nernst's figures as to the dependency of the formation of NO on the temperature, while pointing out the unreliability of theoretical efficiencies based on uncertain assumptions, mentions briefly the technically applied apparatus, and then describes some experiments which he began two years ago together with Mahlke, and which he now publishes because Petersen (D.R.-P. 183,041) suggests the same arrangement. As in Mościcki's disposition [Abstract No. 1385B [1907)], the arc—direct or alternating current—is rotated between two concentric electrodes; the inner electrode is a disc, the outer a ring, while Mościcki applies cylindrical electrodes. The inner electrode should be the kathode which is always hotter than the anode; when the diam. of the inner disc electrode is decreased, the potential rises much more than would correspond to the increased arc length. The author discusses the characteristic of the high-tension arc and the electro-chemical relations. With alternating current larger choking coils are required to steady the arc unless Birkeland's arrangement is adopted, in which the alternating-current arc is re-established at the narrowest part of the gap. The yields per kw. are the same for direct and for alternating current and the author's figures practically confirm those of Birkeland. H. B.

184. *Experimental Investigation of the High-tension Arc.* **G. Brion.** (Zeitschr. Elektrochem. 13. pp. 761–786, Nov. 29, 1907.)—Full particulars of the experiments mentioned in the preceding Abstract, begun with Mahlke and later conducted with the assistance of Frahm, Koch, and Schroeter, and of several firms. The air, dried and preheated up to 600° C., passed upward through the furnace at rates of 250 litres (maximum) per min. under a head of 4 or 5 cm. of water. The preheater conduits of firebricks were heated by nickel wire coils. The two concentric ring electrodes were arranged at adjustable distances. In order to keep the furnace air-tight the excess gas pressure inside was kept below 1 mm. of water; the gases were withdrawn for analysis through the conical top of the furnace, whose walls taper immediately above the electrodes and the external magnet coils. H. B.

185. *The Formation of Nitric Oxide in the High-tension Arc.* **F. Haber** and **A. Koenig.** (Zeitschr. Elektrochem. 13. pp. 725–743, Nov. 15, 1907. From the Inst. f. physikal. Chemie u. Elektrochemie d. techn. Hochschule, Karlsruhe.)—The authors arrange their apparatus like Grau and Russ [see Abstracts Nos. 1251, 1429, 1969 (1907)], but work under diminished gas

pressure in mixtures of N and O flowing at slow rates. The vertical electrodes end in bulbous enlargements of a tube of glass or quartz, which is provided with a water-jacket. The temperature of the inner quartz wall did not exceed 200°. The inner glass wall became much hotter; in these cases the discharge passed along the now conducting glass, and the glass cracked. The voltage of the alternating currents ranged up to 7,000 volts. Inclining to believe with Warburg that the collisions of the electrons play a part in the oxidation, not only by the glow discharge, but also in the arc, the authors reduced the gas pressure. The free paths would then be longer, and the kinetic energy acquired by the moving electrons would increase; but as the potential gradient diminishes with decreasing pressure, the yields of NO did not much improve, and the best yields of 14·4 per cent. of NO were obtained with mixtures of about equal parts of N and O. The average temperature of the gas would, according to thermodynamical calculations after Nernst or Haber, be near 4,650°. In reality the gas temperature probably did not rise above 3,000°. Exact calculations are hardly possible, since we cannot separate the air flame from the arc discharge. The authors, abandoning the views which they formerly held with others, would now recommend cold—and not very hot—arcs for the fixation of nitrogen. H. B.

186. *Work done in Electrolysis.* **J. W. Richards.** (Amer. Electrochem. Soc., Trans. 11. pp. 185–188; Discussion, pp. 188–192, 1907.)—The author has endeavoured to determine the proportion of electrical energy absorbed by an electrolytic cell which appears as heat, and the proportion becoming latent in doing chemical work. The energy disappearing in doing chemical work was determined by measuring the total energy of current used by the cell, and determining the heat set free calorimetrically by the rise in temperature of the cell. Using a solution of $H_2SO_4 . 200H_2O$ and Pt electrodes, it was found that 1·61 volts of the 3·73 volts used disappeared in chemical work. With a solution of $CuSO_4 . 200H_2O$, a Cu kathode and Pt anode, 1·59 volts out of 4·48 disappeared in chemical work. This agrees closely with the chemical work required to separate H_2 and O from H_2SO_4, and very poorly with the chemical work as calculated from the heat of formation, viz., 28,150 cals. per $Eq = 1·23$ volts. The discussion which followed centred round the question whether the voltage equivalent of the expansion of the gases evolved on electrolysis had really been taken into account in the calculations. T. S. P.

187. *Thermo-chemical Efficiency of Direct and of Alternating Currents.* **H. Lee** and **A. Beyer.** (Zeitschr. Elektrochem. 13. pp. 701–707, Nov. 1, 1907. From the Laborat. f. Elektrochemie u. physikal. Chemie d. techn. Hochschule, Dresden.)—The authors maintain arc flames between rod electrodes of various materials, pushing blocks of iron over the rods to keep them cool, and determine the number of gm. of nitric oxide (NO) produced by 100 watts, with direct currents and with alternating currents of 25 ∿. With iron electrodes the arc required about 60 volts, with alternating currents about 150 volts; the yields of NO were the same. Similar results were obtained with Pt electrodes and with electrodes consisting of Nernst glowers; the latter gave higher yields than the other electrodes. It would hence appear to be unnecessary to interrupt and remake the arc at rapid intervals. They further produced calcium carbide in a graphite crucible, heating mixtures of lime and anthracite by means of the arc with carbon electrodes at 85 or 60 volts; direct and alternating currents yielded practically equal weights of CaC_2. H. B.

188. *Electrolytic Pickling of Steel.* **C. J. Reed.** (Amer. Electrochem. Soc., Trans. 11. pp. 181–183; Discussion, pp. 183–184, 1907.)—According to the author, higher oxides, as well as the metal, are dissolved at the kathode and deposited at the anode. The cases of PbO_2 and CuO in batteries are exceptions, because $PbSO_4$ is hardly soluble in sulphuric acid and CuO in alkali. When iron covered with black fire-scale Fe_3O_4 is electrolysed at low temperature in dilute sulphuric acid, the iron underneath the scale is dissolved and the scale is removed mechanically, falling off; but when acid of density 1·25 is applied at 60° C. with currents of 70 amps./sq. ft., only the scale is dissolved, and the resulting ferrous sulphate can be gained by cooling; the acid can be replenished by bringing SO_2 to the anode. This pickling is thus inexpensive; it can, however, not well be applied to coils, because it is difficult to secure good contact with the interior of the coil, which is a poor conductor. In the *discussion*, **C. F. Burgess** did not consider the matter so simple; **C. A. Doremus** mentioned that K. F. Stahl has recommended hydrofluoric acid for removing scale, not only when the scale was siliceous, and also for removing rust stains from linen. The author has not tried his process on a large scale. H. B.

189. *Rapid Analysis by Electrolysis without Rotating Electrodes.* **F. C. Frary.** (Amer. Chem. Soc., Journ. 29. pp. 1592–1596, Nov., 1907.)—Improved forms of apparatus [see Zeitschr. Elektrochem. 13. pp. 308–309, June 7, 1907] by means of which the electrolyte is rapidly rotated in a magnetic field (due to a solenoid), the electrodes being stationary, are described. In the first apparatus the solenoid consists of about 500 turns of 1·5-mm. insulated copper wire, and is wound on a copper cylinder 6 cm. diam. and 11 cm. high, the flanges of the cylinder being of sheet iron. A hollow iron cylinder stands in the lower part of the solenoid, and the latter is also surrounded by an iron mantle. In this way the entire magnetic field of the solenoid is concentrated in that portion of the core lying above the inner iron cylinder. It is in this portion of the core that the beaker containing the electrodes—spiral anode and gauze kathode—and the electrolyte is placed. The electrolytic cell and the solenoid may be connected in series or worked by separate circuits. When the solenoid is put in action, and at the same time a current passed through the electrolyte, the lines of force cause the electrolyte to rotate continuously, the speed of rotation depending on the current used. The heat developed in the solenoid may be used for warming the electrolyte, but if this is not desired the beaker may be surrounded by a spiral of lead pipe through which cold water flows. The second apparatus is designed for use with a mercury kathode. The principle is the same, but the relative directions of the field and current are reversed, the current lines being vertical and the direction of the magnetic field being radial. T. S. P.

190. *Rapid Determination of Zinc by Electrolysis.* **F. C. Frary.** (Amer. Chem. Soc., Journ. 29. pp. 1596–1603, Nov., 1907.)—Using the first form of apparatus described in the preceding Abstract, the author has studied the electrolytic determination of zinc. Solutions of sodium zincate were used, since it was found that an acetate solution gave a coarsely crystalline deposit of metal, which was easily brushed off from the surface of the gauze kathode. 0·1 gm. Zn can be completely precipitated by 4·5 amps. in 30 min. on a Ni-gauze kathode. About 6 gm. of sodium hydroxide should be used, and the electrolysis should be conducted at as low a temperature as possible.

For quantities of Zn up to 0·2 gm. the current strength should be 4–5 amps. for 15 min. and then about 1·5 amps. for 20 min. The author points out that it is absolutely necessary to test the liquid remaining after electrolysis, since concordant results can very often be obtained and yet all the Zn not be deposited from solution. It is highly improbable that complete precipitation of 0·2 gm. Zn can be obtained with 5 amps. in 15–20 min., as stated by Exner and Ingham. From the results obtained it would also seem improbable that the concordant results obtained by Langness with 10–13 amps. in 8 min. represent complete precipitation. [See Abstracts Nos. 1667 (1905) and 1264 (1907).] T. S. P.

191. *Electrochemical Determination of Small Quantities of Zinc.* **W. Neumann.** (Zeitschr. Elektrochem. 13. pp. 751–752, Nov. 22, 1907. Physikal.-chem. Inst., Leipzig, Oct., 1907.)—The author deposits zinc on a copper kathode from an alkali zincate solution in a small test-tube or a narrow glass tube. The electrodes, Pt and Cu, are wires, 0·5 or 0·1 mm. in diam.; the anode wire ends in a bead, and the kathode is examined under the microscope. 0·16 millionths of a gm. of zinc may thus be determined; the white deposit of Zn should redissolve in KOH. The presence of Cl' and NO_3' must be avoided. H. B.

192. *Electrolytic Deposition of Nickel-Zinc Alloys.* II. **E. P. Schoch** and **A. Hirsch.** (Amer. Electrochem. Soc., Trans. 11. pp. 135–151; Discussion, pp. 151–152, 1907.)—In continuation of their previous work [see Abstract No. 980 (1907)] the authors first endeavoured to deposit alloys of Ni and Zn containing a higher percentage of Ni than those previously obtained, the proportion of Ni to Zn in the electrolyte being greatly increased. Using kathodes of Pb and Pt, and solutions containing the sulphates of Ni, Zn, and Al, very low yields were obtained, and very often the deposits were powdery. Ammoniacal solutions also gave low yields, but the deposits were reguline, though with a dull dark surface. The alloy contained a relatively large proportion of Zn in every case. Similar results were obtained with a mercury kathode. Further experiments showed that the alloying of Ni with Zn reduces the potential of both metals, the mutual specific effect being such that in an alloy of approximately 70 per cent. Ni and 30 per cent. Zn the potential of the two constituents are equal to each other, and equal to the discharge potential from a solution containing 2 per cent. zinc sulphate and 98 per cent. nickel sulphate (in equivalents). Under these conditions the proportion of Zn obtained in the alloys is at its maximum, and the discharge potential of the solution mixture is at the minimum. Fusion experiments showed that Ni dissolves in molten Zn up to 25 per cent. (nearly); alloys with a greater percentage of Ni have a melting-point far above the boiling-point of Zn. A few results of the determination of the equilibrium conditions of Zn, Ni, and their alloys, with solution mixtures of their sulphates are also given. T. S. P.

REFERENCE.

193. *Relations between Heat Effect and Free Energy.* **H. v. Jüptner.** (Zeitschr. Phys. Chem. 60. pp. 114–119, July 28, 1907.)—The author discusses the significance of the relation $d(\log p)/d(\log T) = Q/A$ [compare Abstract No. 175 (1908)] and its application to changes of state and to chemical changes [compare Nernst, Abstract No. 580 1907)]. T. H. P